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Drivers of the peasant households' part-time farming behavior in China

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ABSTRACT

Rural households in China are now diversifying from full-time agriculture to part-time griculture where they are engaging in different off-farm activities along with farming. Understanding the driving factors that affect the peasant households' part-time farming behavior has significant implications for rural developing and farm income support policy. This study intend to identify the driving factors to affect the peasant households' part-time farming behavior and present some corresponding proposals. A total sample of 2074 households from 3 district 9 provinces was selected through purposive sampling technique. While confirming some findings of previous research with respect to the effects of human capital and household peasant characteristics on part-time farming participation, this study shows differential impact of those variables. The results show that the degree of part-time farming in eastern China is higher than that in central and western China. There is a small difference between central and western China. The top 5 factors influencing the peasant household's part-time behavior, in order, are the area of farmland per capita (AFC), the distance from village to county center (TCC), the proportion of paddy field (PPF), the distance from village to town center (TTC), and the householder's age (A). It shows that the influencing factors vary among different regions based on the analysis of eastern, central and western China. The study recommends the implementation of policies that facilitate rural off-farm activities and enhance balanced economic growth of the country.

1. Introduction

Part-time farming has been pervasive for centuries in rural areas and has long been recognized as a global phenomenon (Cavazzani and Fuller, 1982; Bouchakour and Saad, 2019). Part-time farming is a well-studied phenomenon in industrialized countries. The most statistics show that half of farm households were losing money on farming and were relying on no-farm income to support their families in US (USDA, 2019b). However, contrary to expectations, part-time farming appears to be more prevalent in developed than in developing countries. For example, part-time farming is practiced by far more farmers in Norway (74.6 percent), the United States (54.8 percent) and Switzerland (52.8 percent) than in Morocco (21.2 percent) and Syria (31.4 percent). Such a divergence could be explained by the high skill level of farmers in developed countries compared to the poor human capital quality in the developing world.

The massive part-time farming in China has attracted great research interest in recent years. China is short of arable land resource. The scarcity of agricultural resources makes the per capita income of farmers always low. The rural redundant labor left land to participate in off-farm activities. The rapid movement of rural labor force has led to the increased part-time farming (Hao et al., 2013). This transition has altered the marginal productivity of labor and hindered the adjustment of rural industrial structure (Liu et al., 2016; Long et al., 2016). It has become a prominent feature of rural transformation in China. With the relaxation of the *hukou* (registered permanent residence) system and other restrictive regulations, as well as the rapid development of the Chinese economic, the labor force has moved from rural to urban and from agricultural to non-agricultural in China (Yang et al., 2016). Local off-farm employment has also emerged as an important local economic activity in terms of employment and income generation (Yang et al., 2016).

Part-time farming plays increasingly important role in sustainable economic development and poverty reduction in rural areas. The flow of China's rural labor force into the off-farm sector has been steadily growing. The proportion of rural labor force engaged in off-farm

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employment rose from 34 percent in 1995 to 61 percent in 2011 (Rozelle et al., 1999; Li et al., 2013). A nationwide survey conducted annually by NBSC[1] (2017) showed that migrant off-farm workers totaled 282 million in 2016 in China, of whom 169 million left their home towns and townships for more than six months (more than 80 percent entered cities), leaving 112 million engaged in non-agricultural employment in their home towns and townships. Accordingly, after 2004, labor-saving agricultural mechanization developed very rapidly and labor inputs in agriculture were significantly reduced (Cai et al., 2013).

Part-time farming also brings about a series of social problems. On the one hand, farmers "go to town" but do not "abandon land", resulting in the formation of hollow village, which not only makes the land use more and more extensive, but also hampers the improvement of rural living environment (Long and Liu, 2016; Long et al., 2016; Yao and Xie, 2016; Fang et al., 2016). On the other hand, farmers are away from agriculture rather than land, which makes it difficult to form effective agricultural land circulation. The retention of part-time farming impedes the adjustment of industrial structure and the advancement of agricultural modernization (Chen and Zhao, 2017). Furthermore, part-time farming has a significant influence on land use behaviors such as investment in the quality protection of cultivated land, agricultural machinery usage, land circulation, groundwater irrigation and so on (Hao et al., 2013; Caffaro et al., 2017; Lu et al., 2018; Yin et al., 2018). The proportion of off-farm employment has altered households' production behavior (Liu et al., 2013) and the allocation of land.

The main purpose of this paper is to identify the regional differences and the drivers of part-time farming bahavior in China. Part-time farming as a phenomenon has attracted a lot of attention in China. The vast majority of empirical studies have focused on a handful of districts. In contrast, part-time farming in China has largely been neglected by policymakers. Our main contribution is to use farm-level survey data from 9 provinces in China. Although various regions of China are heterogeneous and might not be well represented by nine provinces, we contend that we can still learn from this data given that 9 provinces shares China's characteristics. To this end, we use a sample of 2704 peasant households selected from three 9 provinces in eastern, central and western China. Then the boosted regression trees (BRT) model, which has the characteristics of judging the effect of independent variable on the dependent variable to some extent, was used to analyze the influencing factors of peasant households' part-time farming behavior in eastern, central and western China. Thus, the regional spatial difference law of the behavior of peasant households' part-time farming and its influencing factors can be understood. According to the analysis results, the study recommends the implementation of policies that facilitate rural off-farm activities and enhance balanced economic growth of the country.

2. Theoretical background

In this paper, with respect to full-time farming households, part-time farming households refers to the rural households who participate in off-farm employment and earn a substantial portion of income from outside the farming while do not stop engaging in agricultural production (Hao et al., 2013).

Part-time farming is widely practised throughout the world. In the developing world, part-time farming is viewed mainly as a means of survival. In most countries, part-time farming appears to be motivated by necessity rather than choice. Farming is often no guarantee of an adequate income. Seasonality, climatic and other natural risks have always governed both the level and risk of farm income (Bouchakour and Saad, 2019). Farmland abandonment often occurred in mountainous areas and other areas with difficult production circumstances in Europe. The abandoned farmland often had relatively low productivity, located on steep gradients and with poor soil (Alasia et al., 2009). In China, part-time farming is also caused by the attractive opportunities available in urban areas, and by the difficulties encountered in rationalizing production in farming regions. The remaining farmers took over the farmland left by the migrating farmers in more prosperous areas, but farmland was abandoned in agriculturally poor areas (Gao et al., 2018). So the conflict between land shortage and labor surplus appears even more serious in some poor mountainous areas (Liu, 2017). The scarcity of agricultural resource makes farm income per capita always low. In such a situation, off-farm sectors are particular important in absorbing agricultural labor surplus, enhancing farmers' incomes and reducing rural poverty (Liu, 2017).

Plenty of studies have been conducted on the factors influencing rural laborers' participation in part-time farming. Taking the north of the Netherlands as study area, van Leeuwen and Dekkers (2013) analyzed how household, farm and spatial characteristics determine the share of off-farm income and how they affect spatial patterns of farmers who can benefit from it. He found that the farmers who benefit most from off-farm job opportunities are the ones close to the larger cities, as well as the ones in the regions where the farmers are younger and where they are often involved in dairy or arable farming. In areas where the landscape is dominated by large-scale dairy farms with little access to jobs, a low level of off-farm income can be found. However, especially the arable and dairy farms are currently receiving a relatively large amount of agriculture payments from the EU. Liu (2017) identified the determinants of China's rural households' off-farm participation by using the survey data of Hubei Province. He found that potential income differential serves as the major positive correlation influencing factor that affects off-farm work participation. Education and proximity to a city are crucial in helping peasant households to participate in off-farm work. while the land shortage or the labor surplus act as the negative correlation influencing factors in off-farm work participation. Better quality of land reduces the household's propensity to participate in off-farm activities. Jia and Petrick (2014) analyzed the linkages between land fragmentation and off-farm labor supply by drawing upon a rural household panel data set collected in Zhejiang, Hubei, and Yunnan Provinces of China. The result shows that land fragmentation indeed leads to lower agricultural labor productivity, implying that land consolidation will make on-farm work more attractive and thus decrease part-time farming labor supply. The decision to participate in part-time farming is assumed to be affected by individual, family, farm, local and regional economy condition. Peasant households' part-time farming are influenced by householders' age, gender, human captial, the household financial position, endowment of family resources and other factors (Jia and Petrick, 2014; Bouchakour and Saad, 2019). Other things being equal, age has a hump-shaped effect on the probability of off-farm work (positive for young farmers and negative for old farmers). While a higher level of education leads to a higher off-farm salary, it also leads to increased farmer productivity. At the household level, due to the widespread view that males have greater "investment value" than females, females are in an inferior position and, as such, may miss out on educational opportunities and suffer from low family status, which leads to unpaid employment at home and limited opportunities to engaged in off-farm work in cities and towns (Maligalig et al., 2019). Households with greater land endowments are more involved in agricultural production, thus leading to a reduction of part-time farming. The household size and all education levels give rise to the off-farm labor supply, while the land endowment dampens it. Households with more members have stronger intentions to participate in part-time farming than other households. Households with better education have more opportunities to supply more part-time farming labor than other households, which supports findings by other authors indicating that increasing years of schooling contributes to the participation of part-time farming work (de Brauw et al., 2002; Uchida et al., 2009). An increase in the off-farm wage significantly leads to an increase of the off-farm labor supply, which is consistent with previous studies indicating that the off-farm wage has a

[1] NBSC: National Bureau of Statistics of the People's Republic of China.

positive relationship with off-farm labor supply (Sumner, 1982; Wang et al., 2007; Jia and Petrick, 2014). Less well-off farmers have a low reservation wage and are thus more likely to accept off-farm work. Similarly, poorer farmers are more risk averse and must diversify their labour portfolio by increasing the share of off-farm work in their portfolio. Most studies, however, find an unambiguous negative relation between household income and off-farm work in developed countries and developing country (Matshe and Young 2004; Serra et al., 2005; Bouchakour and Saad, 2019). Households with more financial resources are less likely to participate in off-farm work. Many researches show that bigger households have a greater motivation to find ways to diversify their income (Matshe and Young 2004; Brosig et al., 2009; Zhao 2014). The larger the household, the more likely it is that the farmer participates in off-farm work. Empirical evidence shows that the importance of off-farm income varies by region and is highly sensitive to the structure of the local economy (Hearn et al., 1996). Liu et al. (2013) and Sofer (2001) show a negative correlation between proximity to towns and off-farm activities.

The supply of off-farm labour has been shown to be positively related to urban proximity ((Lass et al., 1991; van Leeuwen and Dekkers, 2013). Chaplin et al. (2004) find that public transport in countries as Poland and Hungary has a positive effect on off-farm employment. However, Goodwin and Mishra (2004) find that distance to the nearest town, representing the cost of commuting, does not appear to significantly influence the supply of labour off the farm for US farm families. In addition, according to Boisvert and Chang (2009), there is some indication that the strength of the local economy, as measured by the proportion of jobs that are in manufacturing, increases the likelihood of participation in off-farm work.

3. Data and methodology

3.1. Data and sampling

Although these studies have provided a framework for the analysis of peasant household part-time farming behavior and its driving factors, the most existing studies are mostly confided to one area. Moreover, China has a wide geographic area. There are obvious differences in the social and economic conditions, and natural resources endowment in different regions. We argue that peasant households' part-time farming behavior has been influenced by various factors. Because of the geographical factors, historical factors, economic conditions and so on, it shows that the part-time farming behavior is of regional unbalance. Influencing factors of the peasant household's part-time farming in three regions were analyzed: eastern, central and western regions. Accordingly, this study may increase the understanding of various influencing factors on part-time farming behavior. Taking family as a unit for theoretical analysis is of great practical significance to China. Because the household is one of the most stable social organizations in China (Hao et al., 2013; Wang et al., 2017). In family decision-making, the head of the household is often in charge of deciding which family members go outside of the home to find off-farm jobs or remain at home to engage in agriculture, according to individual characteristics and family needs.

The data used in this study consists of two parts: data at the household level and data at the provincial level. Provincial level data were from the China Statistical Yearbook and the China Rural Yearbook. Household level data were from a rural household survey in China conducted during July to September 2015. Applying stratified sampling and random sampling method, 105 sample counties out of 9 provinces were selected.

The steps of the sampling method were as follows: (1) Choose six indicators including total population, the regional per capita GDP, arable land area, the percentage of cultivated area, the proportion of agricultural population and agricultural output value accounting for the share of GDP, which is among the best predictors of rural resource endowment (Ratna et al., 2008). (2) Use the cluster analysis method to investigate the geographical distribution of eastern, central and western China. (3) Selects 3 provinces in each region, namely Guangdong, Jiangsu and Liaoning in eastern China, Jiangxi, Henan and Shanxi in central China, and Sichuan, Guizhou and Ningxia Hui Autonomous Region in western China. (4) Select 31 counties of three provinces in eastern China, 1007 rural households randomly from a list of household heads in sample counties, accounting for 37.24%. (5) Select 28 counties of three provinces in central China, 1018 rural households randomly from a list of household heads in sample counties, accounting for 37.56%.(6) Select 46 counties of three provinces in western China, 679 rural households randomly from a list of household heads in sample counties, accounting for 25.11%. Thus, a total sample of 2880 households was acquired.

In each sampled household, trained interviewers administered a questionnaire to householder or other knowledgeable adult who responded for all household members. A total of 2880 questionnaires were distributed in 9 provinces including 105 counties, and 2704 valid questionnaires were collected. The effective questionnaire rate was 93.89%. The basic statistical characteristics of 2704 valid questionnaires are listed in Table 1.

Household survey involved 2704 peasants, of whom 1723 householders are male, accounting for 63.72%; 981 householders are female, accounting for 27.44%. The main distribution of householders' age was 'less than 35' and 'from 46 to 55', accounting for 31.54% and 24.89% of the total samples, respectively. The relatively high average age (43.46 years) indicates an apparent ageing of the farming population.1951 householders with junior school education were surveyed, accounting for 72.15%. 1081 householders engaged in agriculture were surveyed, accounting for 39.98%. 978 householders were part-time farmers and workers, accounting for 36.17%. Meanwhile, there are 1598 householders who have off-farm working experience, accounting for 59.1%.

3.2. BRT method

Boosted Regression Trees (BRT) was employed to analyze impacting factors affecting peasants' part-time farming behavior. In the literature,

Table 1
The characteristics of the interviewed householders.

Characters	types	frequency (N = 2704)	Effective percent (%)
Gender	male	1723	63.72
	female	981	36.28
Age	less than 35	853	31.54
	from 35 to 45	583	21.56
	from 46 to 55	673	24.89
	from 56 to 65	408	15.09
	more than 66	187	6.92
Education level	primary school	880	32.54
	Junior school	1071	39.61
	Senior school	412	15.24
	college	341	16.44
Occupation now	farmer	1081	39.98
	part-time farmer	419	15.50
	worker	559	20.67
	village cadre	67	2.48
	others	578	21.38
Does the householder have any work experience?	Yes	1598	59.10
	No	1106	40.90

probit and tobit regression have commonly been applied in similar research (Etim et al., 2011; Wang et al., 2017). In the process of analysis, probit and tobit regression model were not selected, because they could not handle different types of predictor variables, identify very complex and non-linear association among variables, and compute variable importance. Instead, the BRT model was appropriate. BRT can fit complex linear relationships, and it is highly resistant to inclusion of large numbers of irrelevant predictor variables. The BRT algorithm can reduce the residual of the previous model in the gradient direction during modeling, which can improve the prediction accuracy.

BRT is one of several techniques aiming to improve the performance of a single model by fitting many models and combining them for prediction. This approach is based on an automated, data adaptive algorithm that can be used with a large number of covariates to fit a linear surface. BRT uses two algorithms: "regression trees" is from the classification and regression tree ("decision tree") group of models, and "boosting" builds and combines a collection of models (Elith et al., 2008). This method has powerful capacities for handling different classes of predictor variables (categorical, nominal and continuous) and distributions (Gaussian, Poisson, binomial and others), for accommodating missing data and outliers, and for automatically handling interaction effects between predictor variables (De'ath, 2007; Elith et al., 2008). Furthermore, this method has no prior assumptions about the independence of predictor variables.

The BRT model involves generating a sequence of trees, each grown on the residuals of the previous tree (Hastie et al., 2009). Prediction is accomplished by weighting the ensemble outputs of all regression trees. Therefore, this BRT model inherits almost all of the advantages of tree-based models, while overcoming their primary disadvantages, that is, inaccuracies (Friedman and Meulman, 2003). A single base learner does not make sufficient prediction using the training data, even when the best training data are used. It can boost the prediction performance using a series of base learners with the lowest residuals (Shin, 2015). An advantage of using BRT models is that the technique may abstain from selecting predictor variables with large numbers of missing values, which would make the technique robust and applicable for industrial applications. Another advantage of the BRT models when compared to regression tree models is the improved predictive performance in validation (Hastie et al., 2009).

More detailed description of the BRT method can be found in the report of Hastie et al. (2009), and working guides in Ridgeway (2007) and Elith et al. (2008). Chen et al. (2015) used the boosted regression tree method to identify the driving factors for the changes of ecosystem services value in Ganjiang Upstream watershed of China. Chen et al. (2016) used the BRT method to identify the factors that affect their awareness of agricultural non-point source pollution in the Jiangxi Province of China. R.M. Yang et al. (2016) used boosted regression tree (BRT) models to map the distribution of topsoil organic carbon content at the northeastern edge of the Tibetan Plateau in China. Zhang et al. (2016) used it to determine the optimal lag for meteorological factors at which the variance of hand, foot and mouth disease cases was most explained, and to assess the impacts of these meteorological factors at the optimal lag.

3.3. Variables selection

The dependent variable was defined as the ratio of off-farm income to total income. This value is between 0 and 1. The higher the value, the higher the degree of farmers' part-time work.

This study analyzed the factors that influence the peasant households' part-time farming behavior mainly based on the economic migration theory. According to the literature (Matshe and Young 2004; Alasia et al., 2009; Brosig et al., 2009; Hao et al., 2010; Jia and Petrick, 2014; Zhao 2014; Gao et al., 2018; Bouchakour and Saad, 2019; Wang et al., 2019) and actual conditions in the study area, there are 17 independent variables in four categories mainly focused on the householders' personal characteristics, family characteristics, geographic factors and economic factors. Table 2 provides the variables in this study. Below we provide a concise description of these variables, along with the rationale for their use.

(1) The householders' personal characteristics. Age represents the normal life cycle wage pattern (Gould and Saupe, 1989) and it is a proxy for the 'experience' component of human capital (Gunter and McNamara, 1990). The age of the peasant householder has a very important influence on the degree of households' part-time farming. Gender of the peasant householder is included to reflect potential discrimination against females, which may be more prevalent in rural of labor markets (Alasia et al., 2009). Other things being equal, male householders are more likely to take part-time job. There could be various reasons for this. Men generally have better income opportunities in urban environments. Men are typically expected to work hard to improve living conditions for their families. They would therefore have greater expectations of achieving better living conditions for their families through quitting farming and making more money in urban areas (Gao et al., 2018).

Several studies indicate that the level of education affects the choice for part-time farming and the level of earnings and productivity. High education extends the number of jobs for which a person is qualified, with usually higher salaries. High education levels have been associated with high wage levels in rural China (Wang et al., 2019). Marvel and Lumpkin (2007) thought that education increases a person's information and skills, including those needed to successfully recognize and pursue business opportunities. Farmers with off-farm work experience are more likely to participate in part-time farming.

(2) Family characteristics. ①The coefficient of labor population burden. The labor force is one of the basic elements that promote economic growth. The emergence of rural surplus force is the direct cause of the behavior of peasant household part-time farming. Studies from the developing world shows that bigger households have a greater motivation to find ways to diversify their income (Matshe and Young 2004; Brosig et al., 2009; Zhao 2014). The size of the family has a great impact on the family's production and management condition. This effect cannot be seen from a single point of view, and must be combined with the number of family labor force (Gao et al., 2018). The labor force population burden coefficient was introduced to analyze the impact of family size and the number of labor force on the degree of peasant households' part-time farming. ②The area of farmland per capita. The size of the farm increases farm income and reduces farm income risk. Therefore, farm size is expected to reduce the likelihood of part-time farming behavior. It takes a certain amount of labor to operate a certain area of arable land. The bigger the household area, the more the family labor force will be bound (Hao et al., 2010; Bouchakour and Saad, 2019). The area of farmland per capita was introduced to the research. ③The cultivated land fragmentation's degree. Land fragmentation will affect the steadily in increasing number of off-farm employees and rural migrants. It reduces total farm output and agricultural labor productivity (Jia and Petrick, 2014). Land fragmentation indicator is represented by the number of users' average land plots and the average land size. The cultivated land fragmentation's degree equals the total area of cuntivated land contracted by peasant households divided by the number of cultivated land plots. ④ The proportion of paddy field. Paddy fields are easy to cultivate and require less rural labour. So, in order to increase income, surplus rural labor will more likely participate in part-time farming.

Table 2
Variables used to the analysis of the factors affecting the behavior of households' part-time farming.

Category		Variable	Description	Variable assignment
Dependent Variables		Y	The ratio of off-farm income to total income	–
Independent Variables	The householders' characteristics	A	The householder's age	less than 35 = 1, from 36 to 45 = 2, from 45 to 55 = 3, from 55 to 65 = 4, more than 65 = 5;
		G	The householder's gender	male = 1, female = 2;
		E	The householder's education level	primary school = 1, Junior school = 2, Senior school = 3, college = 4;
		JC	Does the householder have any work experience?	yes = 1, no = 0;
	Family factors	LBC	The coefficient of labor population burden	–
		AFC	The area of farmland per capita	–
		FCL	The cultivated land fragmentation's degree	–
		PPF	The proportion of paddy field	–
	Geographical conditions	TC	Traffic conditions	worst = 1; worse = 2; same = 3; better = 4; best = 5;
		T	Terrain	mountain = 1; hill = 2; plain = 3;
		TCC	The distance from village to county center	–
		TTC	The distance from village to town center	–
	Economic development level	THI	Total income of peasant households	less than 10,000 = 1, from 10,000 to 30,000 = 2, from 30,000 to 50,000 = 3, from 50,000 to 100,000 = 4, more than 100,000 = 5;
		FIV	Family income compared to other village farmers	much higher = 1, higher = 2, same = 3, lower = 4, much lower = 5;
		REP	The regional economy level in the province	highest = 1, higher = 2, middle level = 3, lower = 4, lowest = 5;
		REC	The regional economy level in the county	highest = 1, higher = 2, middle level = 3, lower = 4, lowest = 5;
		RET	The regional economy level in the town	highest = 1, higher = 2, middle level = 3, lower = 4, lowest = 5;

(3) Geographic area conditions. The geographical location determines the resource endowment, terrain features and transportation conditions of the households' family. It has great effect on the production and management activities of the households. During the rural economic development, the townships are the core of economic growth, which gather all kinds of production factors and form resources, manpower, capital and other productive advantages. The degree of households' part-time farming is closely related to the distance from the town center. The better the conditions of roads to nearby towns, the easier it is for farmers to go out and participate in off-farm work (Duda et al., 2018). The size of the labour market and its density can affect the likelihood of off-farm employment (Alasia et al., 2009). There is a big difference in resource endowment between counties and towns, so the distance to counties and the distance to towns should be considered.

(4) Economic development level. The economic development level in a region has a profound effect on the employment of local labor force. The higher the economic development level, the stronger the ability to absorb rural surplus labor force (Li et al., 2013). The strength of the local economy, as measured by the proportion of jobs that are in manufacturing, increases the likelihood of farmers' participation in off-farm work. The extent to which the local economy depends on jobs in the trade sector reduces the farmers' likelihood of part-time farming work (van Leeuwen and Dekkers, 2013).

4. Results

4.1. The behavior of peasant households' part-time farming

Peasant households were classified into four types according to the proportion of off-farm employment income in total income of peasant household: full-time farming households, part-time farming householdsI, part-time farming householdsIIand off-farming households. Proportion of off-farm employment income was equal or less than 5% for full-time farming households, more than 5% and equal or less than 50% for part-time farming householdsI, more than 50% and equal or less than 95% for part-time farming householdsII, and more than 95% for off-farming households (Hao et al., 2013). The regional distribution results of farmers in east, central and western regions are listed in Table 3.

According to the above-mentioned classification of households, 245 households were full-time farming households in full sample, accounting for 9.06%. The full-time farming households in the western China were 11.78% of regional samples, which is the highest. The second highest is in eastern China, accounting for 9.04%. The lowest is in central China, accounting for 7.27%. 731 households were part-time farming households I, accounting for 27.03%. The part-time farming householdsIin the central China is 32.32% of regional samples, which is

Table 3
The regional distribution of different peasant household types.

Region	Provinces	The number of household					Constitute (%)			
		Total samples	Full-time farming households	Part-time farming households I	Part-time farming households II	Off-farming households	Full-time farming households	Part-time farming householdsI	Part-time farming households II	Off-farming households
Eastern	Guangdong	547	44	106	225	172	8.04	19.38	41.13	31.44
	Jiangsu	239	17	37	107	78	7.11	15.48	44.77	32.64
	Liaoning	221	30	66	112	13	13.57	29.86	50.68	5.88
	sum	**1007**	**91**	**209**	**444**	**263**	**9.04**	**20.75**	**44.09**	**26.12**
Central	Jiangxi	587	53	151	283	100	9.03	25.72	48.21	17.04
	Henan	230	13	84	86	47	5.65	36.52	37.39	20.43
	Shanxi	201	8	94	85	14	3.98	46.77	42.29	6.97
	sum	**1018**	**74**	**329**	**454**	**161**	**7.27**	**32.32**	**44.60**	**15.82**
Western	Sichuang	214	22	41	78	73	10.28	19.16	36.45	34.11
	Guizhou	239	25	65	132	17	10.46	27.20	55.23	7.11
	Ningxia	226	33	87	87	19	14.60	38.50	38.50	8.41
	sum	**679**	**80**	**193**	**297**	**109**	**11.78**	**28.42**	**43.74**	**16.05**
Total		**2704**	**245**	**731**	**1195**	**533**	**9.06**	**27.03**	**44.19**	**19.71**

the highest. The second highest is in western China, accounting for 28.42%. The lowest is in eastern China, accounting for 20.75%. 1195 households were part-time farming householdsII, accounting for 44.19%. 533 households belong to off-farming households, accounting for 19.71%. The proportion of part-time farming in eastern is significantly higher than it in the western and central regions. To measure the extent of off-farm employment, part-time farming householdsIIand off-farming households were taken as an indicator. The off-farm employment rate in the eastern is significantly higher than in the central and western regions. The proportion of off-farm employment in the eastern China is 64.84%, while the proportion in the central and western China are 60.42% and 59.79% respectively. There is a small difference between central and western China.

The main reason for the disparity is that China's economic level varies among regions. The areas along the coast in eastern China are rather developed, while those in the central and western are backward. The higher the level of economic development, the higher the level of part-time farming. According to National Bureau of Statistics, Jiangsu has the highest per capita GDP in the nine provinces in 2015, at 87,995 Yuan. The proportion of off-farm households in Jiangsu Province is 32.64%, which is the highest. The proportion of full-time farming households in Jiangsu Province is only 7.11%, which is the lowest. The level of urbanization has promoted the level of part-time farming. The urbanization level in the eastern region is significantly higher than that in the central and western regions, and the degree of part-time farming in the eastern region is also higher than that in the central and western regions.

In addition to regional differences, the part-time behavior of Chinese farmers is also affected by other driving factors.

4.2. The drivers of peasant household's part-time farming behavior

The learning rate was set to be 0.005.50% of the data was analyzed, 50% was used for training, and 5 cross-validations were done. 18 independent variables and 1 dependent variable were used for the BRT analysis (Table 2). The results of the BRT method model evaluation are listed in Table 4. The weights of independent variables of BRT analysis in the whole country, eastern, central and western China are listed in Table 5. The result of BRT analysis in whole country[2] is shown in Fig. 1. It can be seen from Table 4 that the ROC values of the four BRT analysis methods are larger than 0.8, indicating the good BRT prediction results.

Table 4
The result of BRT model evaluation.

The parameter types	The whole country	Eastern	Central	Western
training data ROC score	0.93	0.875	0.849	0.924
cv ROC score	0.813	0.817	0.863	0.876

Table 5
The weight of independent variables of BRT analysis in the whole country, eastern, central and western China.

Independent variable	The whole country	Eastern	Central	Western
A	0.091	0.077	0.075	0.142
G	0.004	0.005	0.006	0.004
E	0.032	0.040	0.027	0.018
JC	0.014	0.020	0.009	0.012
LBC	0.042	0.050	0.036	0.043
AFC	0.164	0.231	0.105	0.089
FCL	0.088	0.113	0.069	0.148
PPF	0.102	0.051	0.230	0.062
TC	0.031	0.024	0.030	0.050
T	0.029	0.020	0.016	0.023
TCC	0.106	0.095	0.104	0.094
TTC	0.095	0.091	0.104	0.124
THI	0.041	0.060	0.034	0.030
FIV	0.081	0.061	0.094	0.086
REP	0.036	0.042	0.022	0.046
REC	0.023	0.011	0.024	0.013
RET	0.020	0.010	0.016	0.017

We can see the relative importance of influential factors on the behavior of households' part-time farming in the whole country in Fig. 1 and Table 5. They are as follows: the area of farmland per capita (AFC), the distance from village to county center (TCC), the proportion of paddy field (PPF), the distance from village to town center (TTC), age (A), the fragmentation of cultivated land (FCL), family income compared to other village farmers (FIV), the coefficient of labor population burden (LBC), total household income (THI) and the regional economy level in the province (REP). The contribution of these ten factors accumulated to 84.6%.

Among them, the area of farmland per capita (AFC) has the biggest influence on the household's part-time farming behaviors. 16.4% of farmers' part-time farming behavior is determined, which has overall negative correlated with the degree of farmers' part-time work. The larger the scale of farmland owned by farmers, the more labor will be put into agricultural production, and the less likely they do part-time

[2] There is hardly space here to list the other results of BRT analysis in eastern, central and western China.

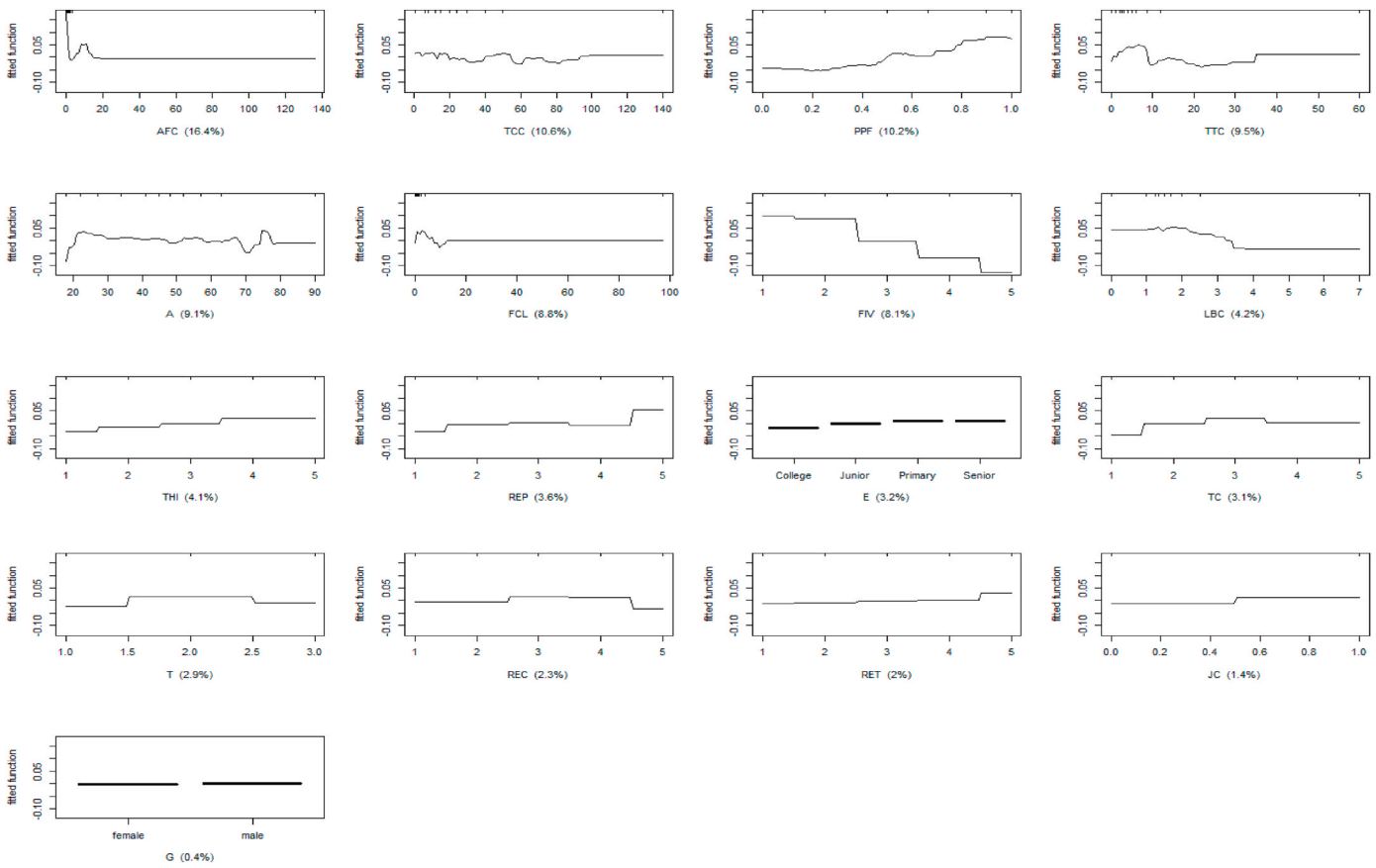

Fig. 1. Partial dependence plots for the seventeen most influential variables in the model for the behavior of households' part-time farming in the whole country. For explanation of variables and their units see Table 1.

farming work. The second bigger factor is the distance from village to county center (TCC), which determines its change of 10.6% and has the overall negative correlation with it. 9.5% of farmers' part-time farming behavior is determined by the distance from village to town center (TTC), which was overall negatively correlated with it. The more convenient the transportation, the more conducive to the mechanization of agricultural production activities and agricultural service outsourcing. It can greatly save the labor input of part-time peasant households to agricultural production activities, which is beneficial to the improvement of wage income of part-time peasant households. The closer a farmer's village is to the nearest township or county government, the more off-farm employment information he is likely to get, the shorter the commute home is likely to be, and the longer the time he spends in part-time employment, the higher his off-farm income.10.2% of farmers' part-time farming behavior is determined by the proportion of paddy field (PPF), which was overall positively correlated with it. The larger the proportion of paddy fields is, the easier it is for farmers to farm, and the less labor they need. So the more labor there is to be able to engage in part-time farming. 9.1% of farmers' part-time farming behavior is determined by the age (A), which was the overall positively correlated with it. The likelihood of peasant households being engaged in part-time farming is growing with the age. Because the older one is, the heavier the burden on his family, the more income is needed to support family members. 8.8% of farmers' part-time farming behavior is determined by the fragmentation of cultivated land (FCL), which was overall negatively correlated with it. The larger the fragmentation of arable land is, the more labor for farming, and the less labor to engage in part-time farming. 8.1% of farmers' part-time farming behavior is determined by family income compared to other village farmers (FIV), which was overall negatively correlated with it. The higher the income of farmers in the village is, the easier it is to choose to part-time farming. 4.2% of farmers' part-time farming behavior is determined by the coefficient of labor population burden (LBC), which was overall negatively correlated with it. With the expansion of family numbers burdened by the unit labor force, more and more family numbers need to be supported. Labor force is hard to go out for work. So part-time farming is impossible. 4.1% of farmers' part-time farming behavior is determined by the total income of peasant households (THI), which was overall positively correlated with it. 3.6% of farmers' part-time farming behavior is determined by the regional economy level in the province (REP), which has the overall positive correlation with it.

In the same way, the influencing factors of households' part-time farming in eastern, central and western regions were analyzed respectively. The results are listed in Table 5. It shows that in different regions, the main factors affecting the farmers' part-time farming behaviors are different. Different regions have different endowments of natural resources and agricultural resources. In eastern China, the top three factors are the area of farmland per capita (AFC), the fragmentation of cultivated land (FCL) and the distance from village to county center (TCC). Their importance was 23.1%, 11.3% and 9.5% respectively, wherein they were overall negatively correlated with it. In central China, the top three factors are the proportion of paddy field (PPF), the area of farmland per capita (AFC) and the distance from village to county center (TCC). Their importance was 23%, 10.5% and 10.4% respectively, wherein they were overall negatively correlated with it. While in the western China, the top three factors are the fragmentation of cultivated land (FCL), age and the distance from village to town center (TTC). Their importance was 14.8%, 14.2% and 12.4% respectively, wherein the correlation is overall positive correlation, negative correlation and negative correlation. The synthesis found that although the main influencing factors were different in each region, the correlation of the same factors in different regions was consistent.

China is a country with a vast territory. The differences in the location, topography, land resources, water resources, regional economic development and climate of each province and region affect the production distribution of agricultural food crops. Furthermore, it affects the allocation of household labor force and the degree of farmers' part-time farming behavior. The development of industrialization has promoted the farmers' part-time farming behavior. Industrialization impact on part-time farming behavior is mainly manifested in the absorption of the rural labor forces. Industrialization and urbanization go hand in hand. The more developed the industrialization is, the higher the urbanization will be. The development of industrialization, especially the development of rural industries and township enterprises, can absorb a large number of rural labor forces, and make it more attractive to local labor force. As a result, local rural labor forces will not have to go too far away from home and obtain off-farm employment. The convenience of transportation is also an important part of the location factor. The development of transportation has greatly shortened the time between the residence of farmers and the place of labor. It has created good off-farm employment conditions for farmers. Therefore, the more convenient the transportation, the higher degree of part-time farming is likely to be. The more convenient the transportation is, the more favorable it will be for the implementation of mechanization of agricultural production activities and the outsourcing of services in all aspects of agriculture, which can greatly save the labor input of part-time farmers in agricultural production activities and promote the wage income of part-time farmers.

5. Conclusions and discussion

5.1. General discussion

No country has experienced the scale of labor movement (from rural to urban and from the agricultural sector to the nonagricultural sector) that China is currently experiencing. Meanwhile, local off-farm employment has also emerged as an important local economic activity in terms of employment and income generation.

As a result, we find that with the increase of per capita cultivated land area, there has been substantial increase in the number of farmers that have increased the scale of their cultivated land. Thus some migrated rural labors have returned to their hometowns to contract in more farmland and joined the farming practice (Zuo et al., 2015). The ratio of off-farm income to total income of these farmer households is in decrease. It is found that village features, such as distance to county center and town and participation significantly affect the ratio of off-farm income to total income. At the individual level, age, the level of education and gender are strongly affect participation in off-farm activities. The level of education can significantly affect the participation in off-farm activities and the level of earnings and productivity. Household with higher level of education are more possible to participate in off-farm activities. Households in areas with bad natural condition are possible to join off-farm activities because of high risks on agricultural production (Liu, 2017). The quantity and quality of infrastructure and population density are often considered as major determinants for the development of rural off-farm sector. In short, the better the infrastructure, the higher the population density, the lower the transaction cost and input for off-farm activities.

If the central government takes responsibility for paying for compulsory education, the cost shouldered by local governments in the *hukou* system reform will be significantly mitigated. The decomposition of income difference find that income gap between off-farm households and full-time farmers is partly due to the difference in resource attributes. The return gap between off-farm and farm production is also important. This result can be explained by higher return of off-farm activities and the spillover effect of off-farm activities on-farm productivity. Accordingly, for the present time, off-farm participation is the most effective choice to increase the income of rural households.

Professional farmers are more able to operate large-scale agricultural machinery, more able to accept and quickly master the application of new technology in agricultural production, and more able to use Internet technology to sell agricultural online and offline. Therefore, cultivating professional farmers is the prerequisite to ensure the increase of income level of full-time farming households. Government can promote the land paid to abandon system. According to land area, it can reclaim the land contract right of the off-farming households who have the intention to enter the city and part-time farming households II, pay a monthly pension, then let the land to full-time farming households at a low price. On the one hand, it can promote the scale operation of land smoothly and improve the agricultural production efficiency. On the other hand, it can help the farmers who have transferred the right of land contract not worry about their retirement and leave agriculture and rural areas more quickly. It also can accelerate the transfer of rural surplus labor force, and promote national economy growth. The development of peasant household's part-time farming has a great relationship with the development of urban secondary and tertiary industries. In particular, the service sector has a strong capacity to absorb rural labor. Therefore, vigorously developing the secondary and tertiary industries in cities is an effective way to encourage farmers to have part-time jobs and provide jobs for the transfer of rural labor force. We should actively support county economic development, promote the transfer of rural labor force to secondary and tertiary industries, provide farmers with more and more stable employment opportunities in cities or towns.

The present study found that agricultural production managers in agricultural developed countries show an aging trend, and farmers' part-time farming behavior is fully developed. It is a fact that young people are fleeing agriculture. This phenomenon has also been verified in the regions where part-time farming is developing rapidly. According to the constitution characteristics of off-farm employment labor force, young labor forces are being drawn to off-farm industries and cities. Although China's agricultural output has not been affected by the peasant households' part-time farming behavior, the aging of rural labor force in China still needs more attention. This will be the focus of the author's future research. Although the survey was conducted late summer and early fall, when farmers were free from farming, as the survey was conducted in the village, it was inevitable that some farmers in the village went out to work, it was a lack of information on these farmers samples. The research scope should be expanded. For example, the rural cadres should have the data of migrant workers and conduct telephone surveys to supplement the overall information. Further studies should be expanded. After getting the data from the village cadres, we will conduct a telephone survey to supplement the overall information.

5.2. Conclusions

Owing to the rapid growth of the off-farm activities, major changes have taken place in rural China since the reform and opening up. Although farming remains the main source of income for rural households, off-farm income is playing an increasingly important role in total income. This study shows that 90.94% of rural households received non-agricultural income, accounting for 63% of total household income. The average income of households that participate in off-farm activities is significantly higher than that of households that participate only in farm activities.

In this study, we investigated the difference of the degree of part-time farming in eastern, central and western China. Under the premise that the construction of urban-rural integration social security system has not been completed, it is inevitable for farmers to do part-time farming based on the basic survival needs of cultivated land. Peasant households take part-time job can not only improve the total family income, but also maintain the survival protection function of farmland. However, part-time farming is also an important factor that leads to the lack of rural transformation and the low level of rural land intensive utilization. The government should play a guiding role in the problem of

farmers' part-time farming. The status of agriculture in the national economy should not be affected by the part-time farming of farmers. To promote the healthy development of peasant households' part-time farming, it is necessary to increase the investment in agricultural infrastructure construction so as to make agriculture move towards modernization and mechanization.

5.3. Policy implications

In order to promote the development of part-time behavior of farmers in China and improve the efficiency of grain production, this study puts forward five policy recommendations. We will increase investment in agricultural infrastructure to promote sustainable agricultural development. We will cultivate vocational agriculture to promote the development of agricultural production to the direction of specialization. We will reform the land system to encourage farmers to move away from land and agriculture. We will create more job opportunities to promote the non-agricultural transformation of farmers and support the development of agricultural and service industries. For example, we can increase off-farm skills training and enhance their off-farm employment competitiveness in the eastern regions with less cultivated land per capita. In the middle and western regions, aiming at the fragmentation degree of farmland being the main factors that influence the households' part-time behavior, we will increase comprehensive rural land consolidation. In reducing the fragmentation of arable land, it is also beneficial to promote the moderate scale operation of cultivated land. Our analysis indicates that education plays a significantly positive role in off-farm participation for rural households, and education increases farm and off-farm productivity as well. Therefore, we can strengthen technical training to improve the education level for rural labors will improve peasant households' part-time farming behavior, which is of great help for the long-run development of rural China.

For example, in the east, where there is less cultivated land per capita, off-farm skills training could be increased to enhance its off-farm employment competitiveness. In the central and western regions, considering that the fragmentation degree of farmland is the main factors affecting the households' part-time farming behavior, the rural land consolidation can be strengthened. Reducing the fragmentation of arable land is beneficial to promoting the moderate scale operation of cultivated land. Strengthening technical training can enhance the education level of rural labor force and improve the part-time farming behavior of farmers, which is of great help to the long-term development of China's rural area.

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References

Alasia, A., Weersink, A., Bollman, R.D., Cranfield, J., 2009. Off-farm labour decision of Canadian farm operators: urbanization effects and rural labour market linkages. J. Rural Stud. 25 (1), 12–24.
Boisvert, N., Chang, H., 2009. Does Participation in the Conservation Reserve Program and Off-Farm Work Affect the Level and Distribution of Farm Household Incomes? WP 2009-34. Cornell University, Department of Applied Economics and Management, Ithaca, New York.
Bouchakour, R., Saad, M., 2019. Farm and farmer characteristics and off-farm work: evidence from Algeria. Aust. J. Agric. Resour. Econ. 59, 1–22.
Brosig, S., Glauben, T., Herzfeld, T., Wang, X., 2009. Persistence of full- and part-time farming in Southern China. China Econ. Rev. 20, 360–371.
Caffaro, F., Mirisola, A., Cavallo, E., 2017. Safety signs on agricultural machinery: pictorials do not always successfully convey their messages to target users. Appl. Ergon. 58, 156–166.
Cai, F., Wang, M., Du, Y., 2013. Understanding changing trends in Chinese wages. In: Huang, Y., Yu, M. (Eds.), China's New Role in the World Economy. Routledge, Abingdon, pp. 69–88.
Cavazzani, A., Fuller, A.M., 1982. International perspectives on part-time farming: a review. Geojournal 6 (4), 383–389.
Chaplin, H., Davidova, S., Gorton, M., 2004. Agricultural adjustment and the diversification of farm households and corporate farms in Central Europe. J. Rural Stud. 20, 61–77.
Chen, C., Zhao, M., 2017. The undermining of rural labor out-migration by household strategies in China's migrant-sending areas: the case of Nanyang, Henan Province. Cities 60, 446–453.
Chen, M., Lu, Y., Ling, L., Wan, Y., Luo, Z., Huang, H., 2015. Drivers of changes in ecosystem service values in Ganjiang upstream watershed. Land Use Pol. 47, 247–252.
Chen, M., Chen, M., Lu, Y., Wang, L., Huang, Y., 2016. The farmers' perceptions of ANPS pollution and its influencing factors in Poyang Lake Region, China. Water Sci. Technol. 73 (7), 1591–1598.
de Brauw, A., Huang, J., Rozelle, S., Zhang, L., Zhang, Y., 2002. The Evolution of China's Rural Labor Markets during the Reforms, vol. 30. Department of Agricultural and Resource Economics, UC Davis Working Paper, pp. 329–353.
De'ath, G., 2007. Boosted trees for ecological modeling and prediction. Ecology 88 (1), 243–251.
Duda, I., Fasse, A., Grote, U., 2018. Drivers of rural-urban migration and impact on food security in rural Tanzania. Food Security 10 (4), 785–798.
Elith, J., Leathwick, J.R., Hastie, T., 2008. A working guide to boosted regression trees. J. Anim. Ecol. 77, 802–813.
Etim, N., Okon, S., Akpabio, I., 2011. Determinants of deprivation among part–time cassava farming households in the humid tropi. Int. J. Agric. Manag. Dev. 1 (1), 45–51.
Fang, Y., Shi, K., Niu, C., 2016. A comparison of the means and ends of rural construction land consolidation: case studies of villagers' attitudes and behaviors in Changchun City, Jilin province, China. J. Rural Stud. 47, 459–473.
Friedman, J.H., Meulman, J.J., 2003. Multiple additive regression trees with application in epidemiology. Statistics Med. 22 (9), 1365–1381.
Gao, J., Strijker, D., Song, G., Li, S., 2018. Drivers behind farmers' willingness to terminate arable land use contracts. Tijdschr. Econ. Soc. Geogr. 109 (1), 73–86.
Goodwin, B., Mishra, A., 2004. Farming efficiency and the determinants of multiple job holding by farm operators. Am. J. Agric. Econ. 86, 722–729.
Gould, B.W., Saupe, W.E., 1989. Off-farm labour market entry and exit. Am. J. Agric. Econ. 71, 960–969.
Gunter, L., McNamara, K.T., 1990. The impact of local labour market conditions on the off-farm earnings of farm operators. South. J. Agric. Econ. 22, 155–165.
Hao, H.G., Li, X.B., Xin, L.J., Tian, Y.J., 2010. Analysis on the part-time employment behavior of peasant households and its causes. J. agro-tech. econ. 3, 14–21 (In Chinese).
Hao, H., Li, X., Zhang, J., 2013. Impacts of part-time farming on agricultural land use in ecologically- vulnerable areas in north China. J. Resour. Ecol. 40 (1), 70–79.
Hastie, T., Tibshirani, R., Friedman, J., Hastie, T., Friedman, J., Tibshirani, R., 2009. The elements of statistical learning. Springer 2 (1) (New York).
Hearn, D.H., McNamara, K.T., Gunther, L., 1996. Local economic structure and off-farm labour earnings of farm operators and spouses. J. Agric. Econ. 47, 28–36.
Jia, L., Petrick, M., 2014. How does land fragmentation affect off-farm labor supply: panel data evidence from China. Agric. Econ. 45 (3), 369–380.
Lass, D., Findeis, J., Hallberg, M., 1991. Factors Affecting the Supply of Off-Farm Labor: a Review of the Empirical Evidence. Multiple job-holding among farm families, pp. 239–262.
Li, Q., Huang, J., Luo, R., Liu, C., 2013. China's labor transition and the future of China's rural wages and employment. China World Econ. 21 (3), 4–24.
Liu, Y., 2017. Pushed out or pulled in? Participation in non-farm activities in rural China. China Agri. Econ. Rev. 9 (1), 111–129.
Liu, S., Zhang, H., Xie, F., Guo, S., 2013. Current situation and influencing factors of off-farm work in mountainous and hilly rural areas of Sichuan Province, China. J. Mt. Sci. 10, 445–454.
Liu, Z., Müller, M., Rommel, J., Feng, S., 2016. Community-based agricultural land consolidation and local elites: survey evidence from China. J. Rural Stud. 47, 449–458.
Long, H., Liu, Y., 2016. Rural restructuring in China. J. Rural Stud. 47, 387–391.
Long, H., Tu, S., Ge, D., Liu, Y., 2016. The allocation and management of critical resources in rural China under restructuring: problems and prospects. J. Rural Stud. 47, 392–412.
Lu, H., Xie, H., Chen, Q., Jiang, J., 2018. Impact of agricultural labor transfer and structural adjustment on chemical application: comparison of past developments in the ecological civilization pilot zones of China and their future implications. Sustainability 10 (6), 1909–1923.
Maligalig, R., Demont, M., Umberger, W.J., Peralta, A., 2019. Off-farm employment increases women's empowerment: evidence from rice farms in the Philippines. J. Rural Stud. (71), 62–72.
Marvel, M.R., Lumpkin, G.T., 2007. Technology entrepreneurs' human capital and its effects on innovation radicalness. Enterpren. Theor. Pract. 31 (6), 807–828.
Matshe, I., Young, T., 2004. Off-farm labour allocation decisions in small-scale rural households in Zimbabwe. Agric. Econ. 30, 175–186.

Ratna, R.V., Gopinath, M.R., Malla, R.Y.V., Soussan, J., 2008. Sustaining rural livelihoods in fragile environments: resource endowments and policy interventions-A study in the context of participatory watershed development in Andhra Pradesh. Indian J. Agric. Econ. 63 (2), 169–187.

Ridgeway, Greg, 2007. Generalized Boosted Models: A guide to the gbm package. Update 1 (1), 1–15.

Rozelle, S., Guo, L., Shen, M., Hughart, A., Giles, J., 1999. Leaving China's farms: survey results of new paths and remaining hurdles to rural migration. China Q. 158, 367–393.

Serra, T., Goodwin, B.K., Featherstone, A.M., 2005. Agricultural policy reform and off-farm labour decisions. J. Agric. Econ. 56, 271–285.

Shin, Y., 2015. Application of boosting regression trees to preliminary cost estimation in building construction projects. Comput. Intell. Neurosci. 1–9.

Sofer, M., 2001. Off-farm work in the Moshav: family farming in Israel. J. Rural Stud. 17, 363–375.

Sumner, D.A., 1982. The off-farm labor supply of farmers. Am. J. Agric. Econ. 64 (3), 499–509.

Uchida, E., Rozelle, S., Xu, J., 2009. Conservation payments, liquidity constraints, and off-farm labor: impact of the grain-for-green program on rural households in China. Am. J. Agric. Econ. 91 (1), 70–86.

United State Department of Agriculture (USDA), 2019. 2019 Farm household income forecast. Available from URL:https://www.ers.usda.gov/topics/farm-economy/farm-household-well-being/farm-household-income-forecast/. . (Accessed 6 March 2019).

van Leeuwen, E., Dekkers, J., 2013. Determinants of off-farm income and its local patterns: a spatial microsimulation of Dutch farmers. J. Rural Stud. 31, 55–66.

Wang, X., Herzfeld, T., Glauben, T., 2007. Labor allocation in transition: evidence from Chinese rural households. China Econ. Rev. 18, 287–308.

Wang, X., Huang, J., Rozelle, S., 2017. Off-farm employment and agricultural specialization in China. China Econ. Rev. 42, 155–165.

Wang, W., Dong, Y., Luo, R., Bai, Y., Zhang, L., 2019. Changes in returns to education for off-farm wage employment: evidence from rural China. China Agri. Econ. Rev. 11 (1), 2–19.

Yang, J., Wang, H., Jin, S., Chen, K., Riedinger, J., Peng, C., 2016. Migration, local off-farm employment, and agricultural production efficiency: evidence from China. J. Prod. Anal. 45 (3), 247–259.

Yang, R.M., Zhang, R.M., Liu, G.L., Lu, F., Yang, Y.Y., Yang, F., Li, D.C., 2016. Comparison of boosted regression tree and random forest models for mapping topsoil organic carbon concentration in an alpine ecosystem. Ecol. Indicat. 60, 870–878.

Yao, G., Xie, H., 2016. Rural spatial restructuring in ecologically fragile mountainous areas of southern China: a case study of Changgang Town, Jiangxi Province. J. Rural Stud. 47, 435–448.

Yin, N., Huang, Q., Wang, Y., 2018. Impacts of off-farm employment on groundwater irrigation in North China. Environ. Dev. Econ. 23 (2), 161–183.

Zhang, W., Du, Z., Zhang, D., Yu, S., Hao, Y., 2016. Boosted regression tree model-based assessment of the impacts of meteorological drivers of hand, foot and mouth disease in Guangdong, China. Sci. Total Environ. 553, 366–371.

Zhao, J., 2014. Rural income diversification patterns and their determinants in China. Agric. Econ. 60 (5), 219–231.

Zuo, Y., Ma, L., Cai, H., Wu, T., Xin, X., 2015. China's on-going debates over large-scale farming: what are the pros and cons? China Agri. Econ. Rev. 7 (3), 338–343.