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Multilevel Modeling of Rural Livelihood Strategies from Peasant to Village Level in Henan Province, China

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Abstract: With the rapid development of China's economy, Chinese peasants now have a growing number of livelihood choices. Rural livelihood strategies are primarily a matter of choice, while the characteristics of the household and village may affect the decision-making process. However, until now, there has been a lack of empirical studies that have been carried out for the identification of the multi-level determinants of rural livelihood strategies. To fill this gap, this paper applies multi-level modeling approach to model rural livelihood strategies in Henan Province, China. The results show that rural livelihood strategies have insignificant between-group variability at the household level, and significant between-group variability at the village level, with the variance at the peasant level accounting for the largest proportion of the total variance. Younger peasants who are male and have a higher education level are more likely to engage in only off-farm work, while peasants with the opposite characteristics are more likely to engage in only on-farm work. Pluriactive peasants integrate the characteristics of the other two groups, and generally live closer to urban areas than the others. In order to reduce rural income inequality and sustain agricultural production, the Chinese government should design effective policies to make farming an appealing livelihood choice, particularly for the young generation.

Keywords: rural development; livelihood transition; agricultural production; off-farm activities

1. Introduction

Since the implementation of reforms and the opening up policy in 1978, China has experienced rapid economic growth, and this process has contributed to 70% of the reduction in poverty across the world [1]. However, in the context of dramatically decreasing incidences of extreme poverty, many Chinese peasants are being left behind and the achievements of development are not being shared [2,3]. In 2016, the per capita disposable income of rural residents was only 36.8% of that of urban residents [4,5]. Under the current market environment, individuals are increasingly paid in accordance with their abilities [6]. As a result, the national Gini coefficient for rural China increased from 0.21 in 1978 to 0.31 in 1990, 0.35 in 2002, and finally 0.40 in 2013 [7,8]. Thus, the most difficult challenge that China is facing is enhancing the capabilities of vulnerable peasants. It is also worth noting that China's ability to produce enough food and sustain agricultural development could be severely threatened because fewer young people are choosing farming as a vocation, and the average age of farmers is rising. Numerous studies have shown that these severe social problems are closely related to rural livelihood strategies [9–12].

The term 'livelihood strategies' is used to denote the range and combination of activities and choices that people make/undertake to achieve their livelihood goals [13]. On a global basis, on-farm and off-farm enterprises are critical components of livelihood strategies that peasants frequently adopt to increase their income [14,15]. With the development of China's economy, Chinese peasants now face a growing number of enterprise opportunities [16]. However, a debate has ensued regarding peasants' livelihood strategies in China. As a country with a long history of agriculture, China still has 215 million agricultural laborers as of 2016 [4,5]. Some studies have reported that agricultural enterprises have brought enormous wealth to peasants in some areas of China [17,18], while agricultural intensification in a specific area can constrain the local development of off-farm enterprises [19]. However, other studies have shown that peasants may prefer off-farm enterprises and grow only time-saving staple crops, or even abandon agricultural enterprises altogether [20,21]. Liu and Li (2017) indicated that nearly 170 million peasant workers, most of whom are young and fit, left their home villages and towns in order to seek jobs in cities in 2016 [22]. Pluriactivity (being engaged in both on-farm and off-farm enterprises) as a livelihood strategy of peasants is a frequent feature of peasant agriculture, and can be found in all locations [23]. Although the income from wages has become the main income source for rural households in China since 2013 [4], many peasants are still interested in farming, even when they have off-farm jobs [24].

Recent studies have proven that rural livelihood strategies are influenced by factors at different levels, with the characteristics of individuals, households, and villages often being considered in these studies [25,26]. However, individuals are nested in households, which can belong to a certain village. Thus, the livelihood strategies of individuals within the same group may have strong similarities [27,28]. Understanding why some peasants choose to engage in only on-farm enterprises, while others participate in pluriactivity or only off-farm employment, will contribute to the design of reasonable policies to sustain agricultural production and safeguard rural livelihoods for vulnerable peasants. However, until now, there has been a lack of empirical studies that have been carried out for the identification of the multi-level determinants of rural livelihood strategies.

To fill this gap, this study aims to demonstrate the multiple and multi-level characteristics that differentiate rural livelihood strategies. More specifically, we address the following research question: who are more likely to engage in only on-farm, pluriactivity, or only off-farm in the context of livelihood diversification in China? This question can be decomposed into the following questions: (a) do rural livelihood strategies have significant between-group difference; (b) are there significant differences among the peasants who participate in only on-farm, pluriactivity, and only off-farm, respectively, and (c) which factors play a critical role in differentiating rural livelihood strategies among the characteristics of peasants, households, or villages? Henan Province has the largest rural population among provinces in China, and the rate of peasants' participation in off-farm employment in Henan is much higher than the national average [19,29]. Therefore, this study chose Henan Province as the study area. The remainder of this article is organized as follows: the next section provides a brief description of the materials and methods. The third section presents the results, while the fourth section and the final section provides a discussion of the results and draws conclusions, respectively.

2. Materials and Methods

2.1. Study Area

Henan Province is located in the central part of China, and has a diverse landscape, with mountains in the west and floodplains in the east (Figure 1). Henan Province has the nation's highest wheat output and second highest rice output, which is the reason that it is known as the "breadbasket of China". In 2016, the permanent urban population of this province was only 48.5%, while the urbanization rate of China reached 57.4% in the same year. In Henan, the average peasant has only 0.26 ha of agricultural land, and 25.7 million peasants left their home villages and towns to seek off-farm employment opportunities in 2012 [30].
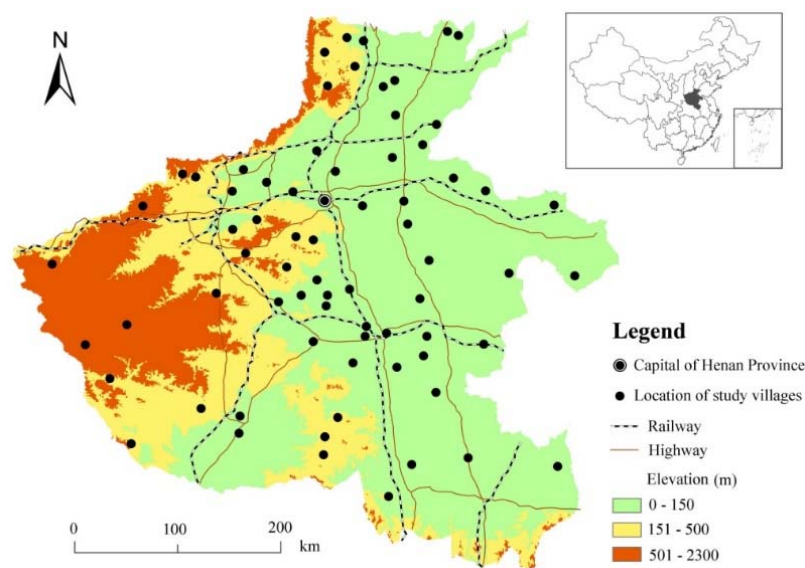
Figure 1. Locations of study villages in Henan Province, China.

2.2. Data Collection

Three large-scale field surveys were conducted from January–February 2015, July–August 2015, and January–February 2016 in Henan Province. Seventy undergraduate and postgraduate students whose hometowns are located in rural Henan were enrolled as investigators, and any characteristic of investigator candidate's home village, such as distance to the nearest urban areas and topography, is not used as the criteria for selecting the investigator. After training, each investigator was required to interview 10 households in their home village. In order to collect reliable information, the investigators selected their relatives or friends as the respondents, and any household characteristic is not used as the selective criteria. In total, the Henan Rural Survey dataset includes information from 700 rural households in 70 villages. These villages are all over this province, involving all prefecture-level cities and landform types (Figure 1).

Each household interview lasted approximately one hour. The content of the household interviews covered demographics, farmland characteristics, farmland transfer, and on-farm, and off-farm systems. From the total of 700 households, 1621 peasants belonging to 691 households in 70 villages were engaged in livelihood activities in 2014.

To achieve accuracy, the highly disaggregated data were collected first, before these data were aggregated by analysis. During March 2015–May 2017, the data obtained from the surveys were checked on a case-by-case basis via telephone follow-up and village revisits.

2.3. Literature Review and Theoretical Framework

In China, peasants' livelihood strategies can be categorized into three types: on-farm, pluriactivity, and off-farm (Table 1). The three livelihood strategies were analyzed using multi-level models in this study, with a binary response (i.e., pluriactivity or not) (Table 1). According to our survey, the numbers of peasants engaged in only on-farm, pluriactivity, and only off-farm strategies in 2014 were 530, 407, and 684, respectively.

Figure 2 presents the rural livelihood strategy framework, with its variables. The potential determinants of rural livelihood strategies were listed at three levels: peasants, households, and villages. The selection of explanatory variables was based on previous research.

Table 1. Statistical description of the variables used in this study.

Variable Name	Description	Min.	Max.	Mean	SD
Dependent variables (Peasant level *n* = 1621)					
Only on-farm	1 if the peasant only engages in on-farm enterprises; 0 if otherwise	0	1	N/A	N/A
Pluriactivity	1 if the peasant engages in both on-farm and off-farm enterprises; 0 if otherwise	0	1	N/A	N/A
Only off-farm	1 if the peasant only engages in off-farm enterprises; 0 if otherwise	0	1	N/A	N/A
Independent variables					
Level 1—Peasant level (*n* = 1621)					
Age	Age of peasants	17	84	44.00	13.51
Gender	1 if the gender of the peasant is male; 0 if the gender of the peasant is female	0	1	N/A	N/A
Education	Educational years of peasants in school	0	19	7.62	3.44
Level 2—Household level (*n* = 691)					
Farm size	Household-owned farmland area (ha)	0	1.53	0.32	0.19
Family structure	1 if the family has members over 70 and (or) under six years of age; 0 otherwise	0	1	N/A	N/A
Level 3—Village level (*n* = 70)					
Topography	1 if the village is located in a mountainous area; 0 if the village is located on a plain	0	1	N/A	N/A
Distance	The distance from the village to the nearest urban area (km)	1	100	20.53	17.80

Note: The laborers in this study were male peasants aged between 16–60 years old and female peasants aged between 16–55 years old.
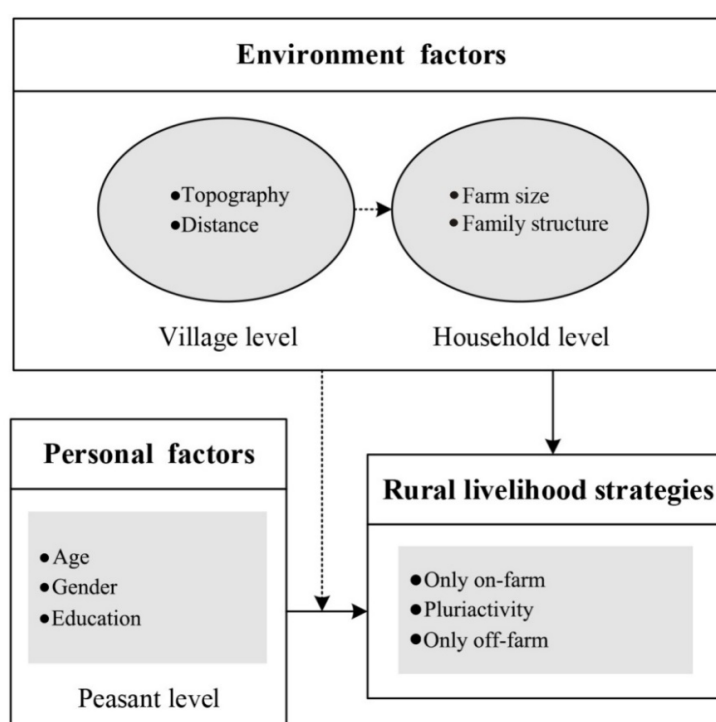
Figure 2. Theoretical framework of rural livelihood strategies in Henan Province, China.

At the peasant level, many studies have reported that the selectivity of rural livelihood strategies is closely associated with age, gender, and educational experience [31,32]. Barbieri and Pan (2013) noted that a larger proportion of younger peasants engage in off-farm labor markets, particularly in urban areas, while older peasants with less mobility tend to engage in agricultural work [25]. Gender is an important factor that may affect rural livelihood strategies, with men engaging in off-farm enterprises proportionally more than women [33]. Education was proven to be one of the most important determinants of rural livelihood strategies, and Barrett et al. (2001) found that a higher education level can increase the probability of participation in higher-return non-farm activities [34].

At the household level, farm size and family structure were chosen to represent household characteristics. Many studies noted that farm size was negatively correlated with peasants' off-farm labor supply, with operators of small farms being more likely to work off-farm than operators of larger farms [35,36]. The inclusive causal relationship between livelihood strategies and family structure has been described in many studies. For instance, Beyene (2008) indicated that a farm household in Ethiopia with a large number of dependents was less likely to participate in off-farm work [37].

At the village level, topography and the distance to the nearest urban area were selected to represent the village characteristics that may affect rural livelihood strategies. The current studies usually use these two selected factors to measure the degree of remoteness and backwardness for a region [38,39]. Fang et al. (2014) indicated that mountain residents frequently face social and economic marginalization and lack access to livelihood assets [40]. Thus, the livelihood strategies in these areas require urgent external intervention. Redding and Schott highlighted that remoteness represents a penalty that disincentivizes people from investing in human capital, which often plays a key role in the creation of rural livelihood strategies. De Janvry and Sadoulet (2001) found that peasants are differentially limited by distance to urban centers in their ability to gain off-farm employment [41].

2.4. Multi-Level Model Specification

Hierarchical levels of grouped data are a commonly occurring phenomenon [42]. The analysis of hierarchical data is best performed using statistical techniques, such as multi-level modeling [43]. Until now, there have been several empirical studies in which multi-level modeling is used to deal with hierarchical data in rural studies [26,44,45]. In this study, the influence of village, household, and peasant-related factors on peasants' livelihood strategies was analyzed using multi-level modeling. For all of the multi-level models in this paper, we use the notations *i* indexes for peasants, *j* indexes for households, and *k* indexes for villages. Since we wanted to estimate a binary response variable (livelihood strategies), we started with two basic two-level logistic regression models, which took the form of simple regressions developed for each peasant:

$$\log\left(\frac{P_{ij}}{1 - P_{ij}}\right) = \gamma_{00} + \mu_{0j}, \tag{1}$$

$$\log\left(\frac{P_{ij}}{1 - P_{ij}}\right) = \gamma_{00} + \gamma_{01}\alpha_{ij} + \gamma_{02}\beta_j + \mu_{0j}. \tag{2}$$

In Equations (1) and (2), *P* is the probability for the occurrence of an event, which is the occurrence of a livelihood strategy type adopted by a peasant in this study; γ_{00} is the general intercept; and μ_{0j} is the group dependent deviation, which is assumed to be independent and normally distributed with a zero mean and a variance of τ_0^2 [46]. Equation (1) is an unconditional model, which does not include any explanatory variables and is usually used to estimate whether the variance of higher levels is significant. Using the model, the variance of the dependent variable can be decomposed into a part caused by the peasant level and a part caused by the group level (e.g., household). Equation (2) is a full conditional model, which includes all of the variables at the peasant level and household level. α_{ij} denotes explanatory variables at the peasant level; β_j denotes explanatory variables at the household level; and γ_{01} and γ_{02} are the regression coefficients.

In our study, we introduced the three-level model (Equations (3) and (4)), which is the expansion of the basic two-level models (Equations (1) and (2)). The unconditional and conditional three-level models are expressed in the following forms:

$$\log\left(\frac{P_{ijk}}{1 - P_{ijk}}\right) = \gamma_{000} + \varepsilon_{0jk} + \mu_{00k}, \tag{3}$$

$$\log\left(\frac{P_{ijk}}{1 - P_{ijk}}\right) = \gamma_{000} + \gamma_{001}\alpha_{ijk} + \gamma_{002}\beta_{jk} + \gamma_{003}x_k + \varepsilon_{0jk} + \mu_{00k}. \tag{4}$$

In Equations (3) and (4), γ_{000} is the general intercept; γ_{001}, γ_{002}, and γ_{003} are the regression coefficients; ε_{0jk} is the random part of the household level and μ_{00k} is the random part of the village level. Equation (3) is the unconditional model and Equation (4) is the full conditional model, including all of the explanatory variables at the peasant, household and village levels. In Equation (4), α_{ijk}, β_{jk}, and x_k are explanatory variables at the peasant, household and village levels, respectively. In this model, $\gamma_{000} + \gamma_{001}\alpha_{ijk} + \gamma_{002}\beta_{jk} + \gamma_{003}x_k$ is the fixed part and $\varepsilon_{0jk} + \mu_{00k}$ is the random part.

To indicate the proportion of variance that is accounted for at the group level, the intraclass correlation coefficients (ρ_ε and ρ_μ for the household and village level, respectively) are calculated. Equations (5) and (6) show the calculation of the intraclass correlation coefficients for the household and village level [46,47]. In Equations (5) and (6), $Var\left(\varepsilon_{0jk}\right)$ and $Var(\mu_{00k})$ are the variance of the random intercept at the household and village level, respectively; meanwhile, the item $\frac{\pi^2}{3}$ implies the residual variance of the peasant level, which is the variance σ^2 in a linear multi-level model.

$$\rho_\varepsilon = \frac{Var\left(\varepsilon_{0jk}\right)}{Var\left(\varepsilon_{0jk}\right) + Var(\mu_{00k}) + \frac{\pi^2}{3}} \tag{5}$$

$$\rho_\mu = \frac{Var(\mu_{00k})}{Var\left(\varepsilon_{0jk}\right) + Var(\mu_{00k}) + \frac{\pi^2}{3}} \tag{6}$$

All three-level models were estimated using the full PQL (penalized quasi-likelihood) approach, with the HLM software [48].

3. Results

3.1. Outcomes of the Unconditional Models

This section presents the outcomes of the unconditional models a (1), a (2), and a (3), however does not include any explanatory variables. Table 2 shows that the variance is not significant ($p > 0.05$) at the household level, but it is significant ($p < 0.001$) at the village level in the a (1), a (2), and a (3) models. Thus, only the villages show significant clustering of the occurrence of peasants who are only engaged in on-farm employment, pluriactivity, or only engaged in off-farm employment.

The intraclass correlation coefficient (ρ_ε) is 0 in the a (1), a (2) and a (3) models, indicating that no variance can be attributed to the household level. In contrast, the intraclass correlation coefficient (ρ_μ) is 0.123, 0.166 and 0.155 in the a (1), a (2) and a (3) models, respectively, indicating that 12.3%, 16.6%, and 15.5% of the variance can be attributed to the village level, respectively, while the remaining variance is at the peasant level. The variance detected in these unconditional models might be accounted for by the explanatory variables in the conditional models of b (1), b (2), and b (3).

Table 2. Multi-level models for peasants' livelihood strategies.

Variables	Engaged in Only On-Farm		Engaged in Pluriactivity		Engaged in Only Off-Farm	
	a (1) Unconditional Model	b (1) Conditional Model	a (2) Unconditional Model	b (2) Conditional Model	a (3) Unconditional Model	b (3) Conditional Model
Fixed effects						
Level 1—Peasant level						
Intercept	−0.756 ***	−1.197 ***	−1.224 ***	−1.369 ***	−0.339 ***	−0.527 ***
Age		0.110 ***		0.031 ***		−0.127 ***
Gender		−1.791 ***		1.240 ***		0.442 **
Education		−0.086 ***		−0.007		0.113 ***
Level 2—Household level						
Farm size		0.015		−0.028		0.028
Family structure		−0.004		0.123		−0.190
Level 3—Village level						
Topography		0.196		−0.015		−0.164
Distance		0.007		−0.021 **		0.011
Random effects						
Level 2—Household level						
Var (ε_{0jk})	0.000	0.330 *	0.000	0.268	0.000	0.475
ρ_ε	0.000	0.077	0.000	0.062	0.000	0.095
Level 3—Village level						
Var (μ_{00k})	0.461 ***	0.664 ***	0.657 ***	0.785 ***	0.605 ***	1.257 ***
ρ_μ	0.123	0.155	0.166	0.181	0.155	0.250

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2. Outcomes of the Conditional Models

The conditional models b (1), b (2), and b (3) introduce a set of explanatory variables for examining the factors that can influence peasants' livelihood strategies. Table 2 shows that younger peasants who are male and have a higher education level are more likely to engage in only off-farm employment, while peasants with the opposite characteristics are more likely to engage in only on-farm work. Statistically, older peasants who are male are more likely to engage in pluriactivity, and they generally live closer to urban areas than the others. Meanwhile, the age coefficient is small and education experience is not statistically significant.

Figure 3 shows that as age increases, the proportion of peasants engaged in only off−farm employment decreases, the proportion of peasants engaged in only on-farm employment drastically decreases, and the proportion of peasants engaged in pluriactivity first increases and then decreases. Figure 4 shows that as educational years increases, the proportion of peasants engaged in only off-farm employment increases, the proportion of peasants engaged in only on-farm employment shows a downward trend, and the proportion of peasants engaged in pluriactivity first increases and then decreases.
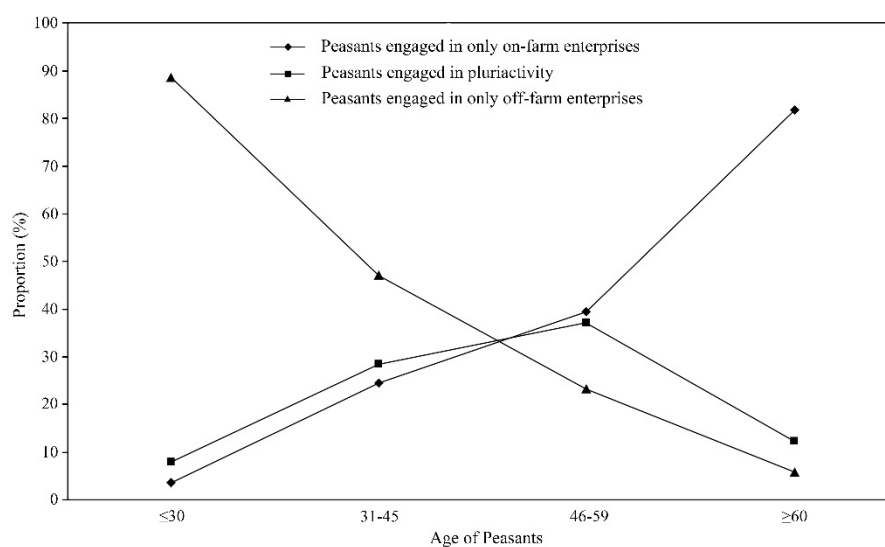

Figure 3. Age differences in livelihood strategies of peasants in Henan Province.
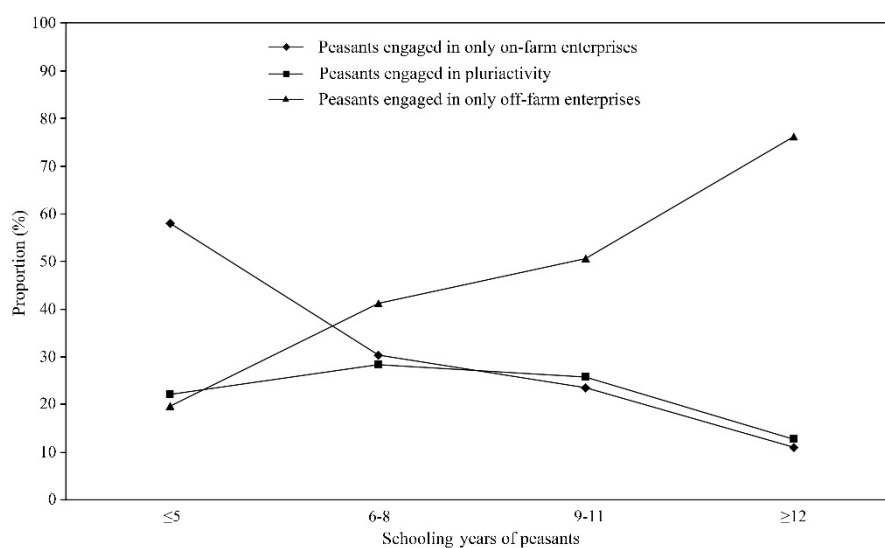

Figure 4. Educational differences in livelihood strategies of peasants in Henan Province.

Table 2 shows that the coefficients of farm size and family structure are not statistically significant in the b (1), b (2), and b (3) models. At the village level, the coefficient of topography is not significant in the b (1), b (2), and b (3) models. The coefficient of distance to urban area in the b (2) model is negatively significant, while it is not significant in the b (1) and b (3) models.

4. Discussion

The unconditional models indicated an insignificant between-group variability at the household level, while the variance at the peasant level accounts for more than 80% of the total variance. This finding is closely related to the individualization of Chinese society. Recent studies show that since the early 1980s, the livelihood dependence on the family collaboration of Chinese peasants has been weakened by the development of a commodity market [49]. This also explains why the family structure does not play an important role in differentiating rural livelihood strategies, as well as the appearance of numerous left-behind people (particularly the elderly, children, and women) in China. In contrast, the unconditional models indicated a significant between-group variability at the village level. Villages are the bases for implementing development strategies in China [50]. Peasants who live in the same village communicate more with each other, live in more similar environments, and own more similar natural resources than peasants in other villages [28]. These factors lead to the similarity of rural livelihood strategies within a village.

The random parts of the conditional models show changes after introducing explanatory variables. In particular, the variances of the conditional models increased and became significant in the conditional model of b (1) compared with the unconditional model of a (1). Although the result could not be explained completely, this could partially be because the changes in the fixed effects part can generally cause significant change in the random part, while changes in the random part usually do not cause enormous change in the fixed effect part [45].

In the past decades, the global rural areas experienced some severe problems, such as rapid aging of the farmers, low income levels and weak production systems [22,51]. China's rural areas are confronted with the same situation. In accordance with most research results, the conditional models indicated that male peasants who are younger and have a higher education level are more likely to engage in only off-farm activities, and peasants who are engaged in only on-farm activities tend to have the opposite characteristics. In Henan, the "best" peasants are rarely attracted to small-scale agriculture. The average farm size is only 0.3 ha in this province, and the growing area of staple crops (i.e., wheat, maize and rice) accounted for 82.5% of the total cropping area in 2014. Consequently, the return from growing crops is quite low, and off-farm income accounted for 85.9% of the total household income in the same year. Furthermore, many studies have noted that work on small farms remains highly labor-intensive and difficult [52–54]. This may explain why farm size does not play an important role in differentiating rural livelihood strategies. The features of pluriactive peasants integrate the characteristics of the former two groups; they are neither the "best" nor the "worst". According to our investigations, the incomes of households engaged in only off-farm activities was 1.1 times and 5.4 times those of pluriactive households and households engaged in only on-farm activities, respectively. Thus, pluriactivity should be seen as an adaptation in order to earn much-needed income by seizing various opportunities, rather than as a way to become a top income earner, at least in the case of this study area.

Rozelle et al. (1999) indicated that the gap between males and females regarding off-farm participation rates narrowed during 1988–1995, which was due to increasing migrant labor market opportunities for women in China [55]. However, this study found that the probability of male participation in off-farm employment was still higher than female participation until 2014. This is because off-farm enterprises that have a preference for males, such as construction, transportation, smelting, security, mechanical maintenance, and manufacturing, provide 44.9% of the total off-farm opportunities, while off-farm enterprises that have a preference for women, such as preschool teaching, housekeeping, cleaning, nursing, and beauty only offer 1.8% of the total off-farm enterprise opportunities.

The distance to the nearest urban area is positively correlated with the occurrence of pluriactivity; however, it is not significantly correlated with the occurrence of the other two livelihood strategies. Henan is a densely populated area. An and Fan (2018) found that urban areas have more off-farm opportunities than rural areas, making it convenient for peasants who live on the outskirts of towns/cities to engage in both on-farm and off-farm enterprises [56]. Since 2006, the Chinese government has greatly improved traffic conditions, and paved roads have connected 97.1% of the selected villages since 2012. Thus, the accessibility of commodity and labor markets has not been constrained by the topographic conditions in Henan Province.

The conditional models of b (1), b (2) and b (3) show that a significant part of variability within these models is left at the village level. Thus, the differences in other village characteristics that were not included in this study might contribute to the village-level variability, and the question what causes villages differences remain unanswered by this study. The limitations of this study also include the neglect of the influence of differences in higher level organizations, such as town, county and city. In the future, case studies referring to more village-level factors and analytical levels are needed to remedy these limitations.

5. Conclusions

This study has shown that multi-level modeling approach can be applied to statistically model rural livelihood strategies. From this study, it can be concluded that rural livelihood strategies have a significant between-group difference. Multi-level modeling approach can be a sound tool to deal with the hierarchically structured data in rural studies. Rural livelihood strategies have insignificant between-group variability at the household level and significant between-group variability at the village level, with the variance at the peasant level accounting for the largest proportion of the total variance. This finding implies that the analysis of rural livelihood strategies at the peasant level is indispensable, and the influence of the village characteristics on peasants' livelihood strategies is a domain worthy of being penetratingly explored.

Younger peasants who are male and have a higher education level are more likely to engage in only off-farm work, and the peasants with the opposite characteristics are more likely to engage in only on-farm enterprises. Thus, the engagement of older peasants in only on-farm enterprises, and their subsequent earning of a lower income, is mainly due to the lack of human capital. However, increasing the human capital of this group will be an arduous task. Furthermore, these older peasants will have to give up small-scale agriculture in the next few decades, while the proportion of peasants aged 30 or younger and engaged in on-farm enterprises only accounted for 11.5% of the total peasants of the same age in 2014. Therefore, in order to reduce rural income inequality and sustain agricultural production, the Chinese government should design effective policies to make farming an appealing livelihood choice, particularly for the younger generation.

Author Contributions: L.Z. designed the analytical framework of this study and wrote the manuscript; C.L. performed the statistical analysis, H.Z. and X.H. made major revisions of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

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