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Household Livelihood Strategy Changes and Agricultural Diversification: A Correlation and Mechanism Analysis Based on Data from the China Family Panel

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Abstract: Social and economic transformations have a profound impact on farmers' livelihood strategies, and changes in these strategies, in turn, deeply impact the agricultural system. Based on four waves of China Family Panel Studies (CFPS) tracking data, this paper uses a Markov transfer probability matrix to explore changes in farmers' livelihood strategies and builds multiple logit and fixed-effect models to empirically analyze the impact and lag effect of these changes on agricultural diversification. The results show that (1) farmers who choose not to shift away from an agricultural livelihood show no significant change in agricultural diversification. Compared with households showing an increase in the agricultural diversification index, households showing a decrease in this index are more inclined to diversify if they choose to maintain an agricultural livelihood either part-time or full-time. For households with an unchanged agricultural diversification index, their index value is more likely to remain unchanged if they choose to maintain a part-time or full-time agriculture-oriented livelihood. Moreover, (2) the impact of livelihood strategy changes on agricultural diversification displays regional heterogeneity. The index value of farmers in the central region shows no statistically significant change over the sample period, while the index value of farmers in the eastern region increases. Farmers in the eastern and central regions with unchanged index values are more inclined to show persistent index values. (3) Changes in farmers' livelihood strategies have a lag effect on agricultural diversification that becomes significant at two lag periods.

Keywords: household livelihood strategy; agricultural diversification; heterogeneity; lag effect; China

1. Introduction

Throughout the development history of the world, agricultural decline in the process of rapid industrialization and urbanization has become a global trend. Since the 1950s, the United States, Sweden, Japan, South Korea and other countries have seen a decline in agricultural economic benefits and a widening of the income gap between urban and rural residents. To improve their income levels, increasing numbers of farmers have left farming to make a living in other sectors. Many farmers have gradually changed from an agriculture-oriented to a diversified livelihood, with the number of agricultural employees rapidly decreasing on a large scale. According to World Bank statistics, the proportion of agricultural workers in the world's total employed population decreased from 64.43% in 1960 to 26.75% in 2019, a decrease of 37.68 percentage points. Taking the BRICS countries (Brazil, Russia, India, China and South Africa) as representatives of the world's emerging markets, during 1960–2019, the employment proportion of Russian agriculture practitioners

in the total population fell by 27.19%, and those of their South African and Indian counterparts by 15.11% and 44.16%, respectively, while the proportion of Chinese agricultural professionals in the total population decreased even more, reaching 57.40% (data source website: https://data.wordbank.org/ (accessed on 12 April 2021)). With the decrease in the number of agricultural employees and the transformation of farmers' livelihoods, farmers must carefully consider how to manage limited land resources to maximize the benefits and diversify their agricultural production structure and nonagricultural management.

Regarding the framework of sustainable livelihood analysis, the UK Department for International Development (DFID) proposed that the household livelihood strategy comprises a combination of related activities taken by farmers to achieve certain livelihood goals based on their livelihood capital in the context of fragile livelihoods [1]. In this framework, livelihood capital can be divided into five categories: natural, social, human, material and financial. Livelihood capital reflects the livelihood resources available to farmers in a multidimensional way and more comprehensively highlights farmers' ability to resist risks by using family endowments. Farmers' choice of livelihood strategies depends on their livelihood capital status and the mode in which this capital is combined and utilized. Compared with other factors, livelihood capital has a more direct and obvious influence on the livelihood strategies of farmers. The natural environment, socioeconomic conditions, assets and other factors constrain farmers' livelihood strategy choices. Scholars in China and abroad have used the sustainable livelihood analysis framework. The peasant household model vividly explains the influencing mechanisms associated with livelihood capital strategies among peasant households, with farmers' social and human capital playing a decisive role in allowing farmers to participate in nonagricultural activities [2–4]. Farmers with higher natural and material capital tend to choose agriculture or agriculture-oriented livelihood strategies, while farmers with higher social capital and financial capital tend to adopt part-time agricultural or nonagricultural livelihood strategies [5,6]. Due to the enduring nature of natural capital and material capital of farmers, the impact of internal and external shocks is relatively small; farmers with greater natural and physical capital tend to choose the more traditional livelihood strategy of agriculture, while farmers richer in human, social and financial capital tend to select livelihood combinations featuring a greater, more diverse range of livelihood modes [7,8]. When internal and external conditions, especially livelihood capital levels, change, farmers often adjust their livelihood strategies by evaluating family endowments and the expected effects of a livelihood change to adapt to new production relations. Relevant studies show that (1) natural capital plays a role in promoting side businesses, (2) farmers with higher human capital tend more towards nonagricultural strategies, (3) material capital promotes agricultural industrialization and (4) financial capital inhibits agricultural industrialization [9]. In addition, farmers' choices of livelihood strategies depend significantly on their previous livelihood strategies. The accumulation of natural, human, social and financial capital promotes an orientation of farmers' livelihood strategies towards high returns, while the binding effect of sunk costs in the form of agricultural fixed assets in physical capital hinders the diversification of farmers' livelihoods [10].

Agricultural diversification is generally regarded as an effective strategy to improve risk management, reduce poverty [11,12] and increase food security. It can reduce the risks caused by internal and external shocks such as natural disturbances, economic crises and poverty and can increase rural income. The core idea of diversification is to maximize utility from available resources. On the one hand, agricultural diversification leads to planting structure diversification, which enables farmers to carry out diversified agriculture in different agricultural ecological environments, which is beneficial for different crops to match different soil environments and climate conditions and is also beneficial for the labor force as it makes full use of the spatial distribution of crop species, which allows for more reasonable time allocation and improves the efficiency of resource allocation. Ultimately, farmers' income and agricultural output will be improved [13,14]. Different crops demand different soil nutrients, so farmers can use different fertilizers to meet crop

planting and growth needs, effectively improving soil fertility and agricultural production efficiency. On the other hand, while diversified planting exposes farmers to different types of risks, it disperses the risks in the planting and production processes and helps avoid or mitigate some sudden natural and market shocks that lead to reduced outputs or fluctuating incomes [15]. For example, Guvele [16] and Niroula and Thapa [17] argue that planting diversification is conducive to reducing natural and market risks in agricultural production and income fluctuations, especially in agricultural areas with labor shortages and frequent natural disasters. Van Hung et al. [18] argue that, based on the current scale of farm operations in China, planting diversification in high value-added agricultural products such as vegetables is conducive to maintaining a relatively reasonable income level for farms. Some scholars have discussed the influencing factors of agricultural diversification and believe that farmers with higher human and social capital tend to diversify away from agriculture [19], which may hinder agricultural diversification. Akpan et al. [20] identify several positive and negative driving factors of agricultural diversification through their research in Nigeria. Anderzen et al. [21] show that access to credit and technical assistance has a positive impact on agricultural diversification. The continuous increase in farmers' off-farm livelihood is in competition with agricultural production, which results in farmers reducing their input in agricultural production to obtain a higher off-farm income. Holden et al. [22] find that an increase in farmers' nonagricultural income reduced their enthusiasm for investment in agricultural production activities, resulting in low agricultural productivity. The decrease in agricultural productivity also affected agricultural production.

Related studies often focus on analyzing a certain aspect of changes in farmers' livelihood strategies and the diversity of farmers' operations but fail to analyze the impact of such livelihood strategy changes on agricultural diversification. In the process of rapid urbanization and urban rural social and economic transformation, farmers' livelihood strategies have undergone fundamental changes. The dependence of the agricultural labor force on subsistence farming has weakened, and changes in livelihood strategies have promoted agricultural diversification. This difference is reflected in the livelihood endowments of different families; farmers' agricultural production decisions have a direct, fundamental impact on agricultural diversification, while family livelihood assets, as the most critical factor affecting rural economic activities [23], directly or indirectly determine family agricultural production. In view of this, the impact of livelihood strategy changes on the agricultural diversification of Chinese farmers is analyzed here. Over the past 40 years of reform and opening, China has experienced rapid industrialization and urbanization, gradually transforming from a rural to an urban society and from an agricultural to a nonagricultural economy. In this process, the livelihood strategy of farmers has changed accordingly, manifesting through the diversification of livelihoods. How can we scientifically characterize these changes in farmers' livelihood strategies? How do such changes affect agricultural diversification? The relevant issues have not been thoroughly studied. In this paper, based on four waves of China Family Panel Studies (CFPS) tracking data, farmers' livelihood strategies are divided according to the proportion of wage income in total household income. A multiple logit regression method is used to analyze the influence of changes in farmers' livelihood strategies on agricultural diversification and discusses the lagging effect of changes in farmers' livelihood strategies on agricultural diversification. This work provides empirical support for promoting the diversification of farmers' income and agricultural development.

2. Theoretical Analysis Framework

Based on the proportion of household wage income in total household income, household livelihoods are divided into the following three types: if household wage income is less than 20% of total household income, the livelihood strategy is agricultural; if wage income is between 20% and 80%, the livelihood strategy is part-time agricultural; and if wage income is more than 80%, the livelihood strategy is nonagricultural. Different types and directions of livelihood strategy change have different effects on agricultural

diversification. The changing types of farmer livelihood strategies can be divided into maintenance livelihoods and variable livelihoods. In this paper, maintenance livelihoods are divided into agricultural maintenance, part-time agricultural maintenance and nonagricultural maintenance, and the variation in household livelihoods are divided into two types: changes towards an agricultural livelihood and changes toward an off-farm livelihood (Table 1). In the following, we analyze the impact of household livelihood strategy changes on agricultural diversification based on the characteristics of the type of change.

Table 1. Changes in household livelihood strategies.

Types of Farmer Livelihood Strategies		Current Period		
		Off-Farm Livelihood	Part-Time Agricultural Livelihood	Agricultural Livelihoods
Base period	Off-farm livelihood	No change in nonagricultural livelihood	Transition towards agricultural livelihood	Transition towards agricultural livelihood
	Part-time agricultural livelihood	Transition towards off-farm livelihoods	No change in part-time livelihood	Transition towards agricultural livelihood
	Agricultural livelihoods	Transition towards off-farm livelihoods	Transition towards off-farm livelihoods	No change in agricultural livelihood

2.1. Impact of Subsistence Livelihoods on Agricultural Diversification

The livelihood system of farmers has a self-organized character [24]. Farmers will make intuitive comparisons based on family endowments and livelihood outcomes, measure the opportunity cost of family endowments and measure the advantages and disadvantages of livelihood outcomes [25,26]. If the results of this assessment are consistent with expectations, the livelihood strategies of farmers in the previous phase will persist in the current period. This is because if farmers repeatedly adjust or constantly change their livelihood strategies, they cannot accumulate enough practical experience in their livelihood development in the corresponding field, and they find it difficult to correctly predict the external risks of the industry. In addition, frequent replacement of livelihood development strategies causes unnecessary loss and waste of livelihood capital for poor families [27], and the best choice for farmers is to maintain their original livelihood strategies at this stage. For maintenance farmers, maintaining the current agricultural planting structure offers results relatively consistent with expectations. The diversity index of maintenance farmers is different due to different agricultural planting structures. Therefore, maintaining the necessary large-scale professional planting is the main way for a farmer to sustain an agricultural livelihood. However, large-scale professional planting may decrease the agricultural diversification index. Farmers who maintain a part-time agricultural livelihood, engaging in both agricultural and nonagricultural production, may maintain a specific farming scale only temporarily or may diversify their agricultural planting structure to meet the family's diversification. As the agricultural planting structure remains unchanged or increases, the agricultural diversity index generally remains unchanged or increases. For farmers who maintain nonagricultural livelihoods, agricultural production has little impact on their livelihood. Therefore, their attitude toward agriculture may be more flexible or emphasize large-scale and specialized planting by other farmers in the form of land transfers, corresponding to no change or to a decrease in the agricultural diversification index (Figure 1).
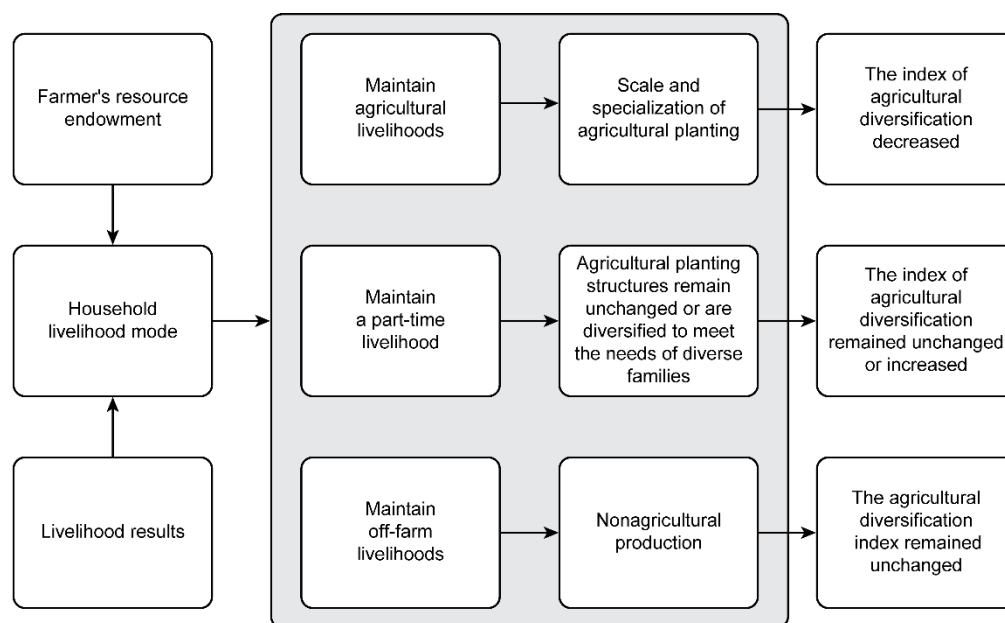
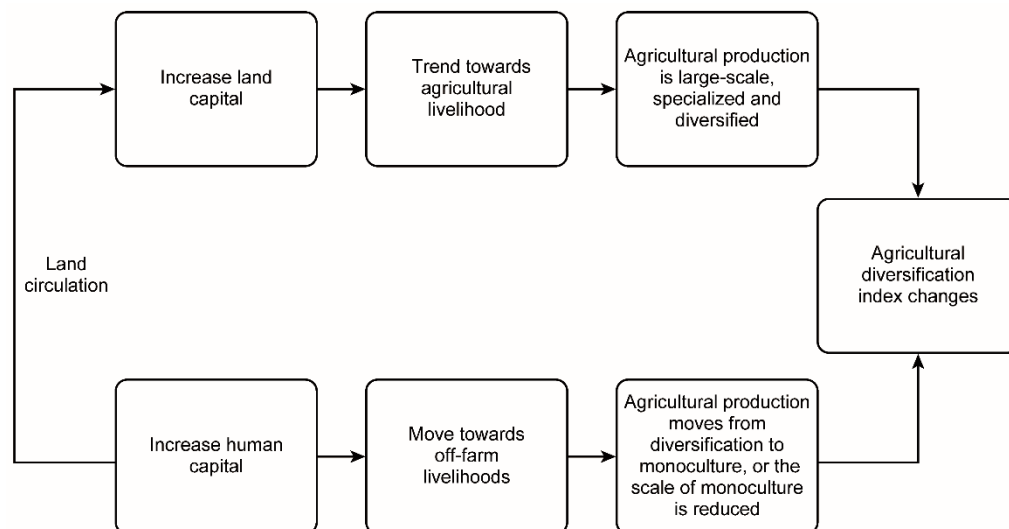**Figure 1.** Impact of maintenance livelihood on agricultural diversification.

2.2. Impact of Farmers' Variable Livelihoods on Agricultural Diversification

Given the coordination of household endowments and livelihood results, when certain external factors are injected into farmers' self-organized livelihood systems, rational farmers will react quickly to these factors and take action on livelihood strategies, thereby driving other farmers to change their livelihood strategies through demonstration effects [28]. For example, the government may attach great importance to agriculture, rural areas and farmers and may have offered a series of preferential policies for farmers. Some farmers have realized that land capital can create more value and have begun to lease more land to operate high-value-added cash crops, changing the original planting structure. These farmers' demonstrations of success drive other farmers to follow suit due to a herding effect. This type of livelihood strategy change is agriculture-oriented. Farmer livelihoods oriented towards agriculture on the premise of expanding land capital can achieve certain livelihood objectives through large-scale and specialized agricultural production, but doing so may hinder agricultural diversification. However, some farmers may diversify their production to disperse risks, which promotes diversified agricultural production.

Farmers' livelihood has the dual objectives of income growth and income stability [29]. The choice of livelihood strategy involves not only the pursuit of higher family income but also the control of risks; however, the agricultural industry has a long production cycle and management issues. Changes to the agricultural planting structure may produce yields that are lower than ideal with respect to the farmers' livelihood goals. Limited land resources in rural areas and the livelihood demands of the increasing surplus rural labor force gradually drive family members to work out of town and seek new outlets, leading to a relatively weakened role of natural capital and an increasingly prominent role of human capital [30,31]. The income of such households comes mainly from nonagricultural labor. These farmers are not completely divorced from agricultural production, as they raise poultry and plant vegetables to meet their basic living needs. Their livelihood strategy changes veer towards off-farm activities. Farmers who prefer nonagricultural livelihoods cannot meet their needs to improve their lives by changing the method of land use, so they pay more attention to nonagricultural livelihoods when making production decisions. Agricultural production may shift from diversified cultivation to monoculture, or the scale of monoculture may be reduced. The uncertainty surrounding agricultural production may lead to transfers of household land [32,33], which are not conducive to the diversification of the household's own agriculture [34]. Through land transfers, large agricultural farmers

may accumulate more natural and material capital [35,36], which makes them more inclined to choose agriculture-oriented livelihood strategies and to plant crops with higher economic value added in combination with more diversified utilization, such that the agricultural diversification index increases (Figure 2).

Figure 2. Impact of farmers' variable livelihoods on agricultural diversification.

3. Index Selection, Research Methods and Data Sources

3.1. Index Selection

The agricultural diversification index is the key dependent variable in this paper. O'Donoghue et al. [37] observed that there are five commonly used indicators to measure agricultural diversification, namely, the maximization index, Herfindahl index (HI), global total entropy index (TE), correlation entropy index (RE) and independent entropy index (UE). Based on the availability of CFPS data, the HI is used to measure agricultural diversification, with products represented by agricultural, forestry, livestock and aquatic products. The formula is as follows.

$$HI = \sum \left(\frac{A_{it}}{\sum A_{it}}\right)^2 \tag{1}$$

$$D_{rt} = 1 - HI \tag{2}$$

A_{it} represents the value of product i at time t, $\sum A_{it}$ represents the sum of the values of all products at time t, and HI is the Herfindahl index, calculated by the sum of squares of the total product value. To make the expression of agricultural diversification more intuitive, we use the inverted Herfindahl index to represent agricultural diversification, namely, Equation (2), where D_{rt} is the diversification level of household r at time t; the value of the agricultural diversification index D_{rt} is between 0~1, where the larger the value is, the higher the degree of agricultural diversification. A smaller value indicates a higher degree of agricultural specialization.

To study changes in farmers' livelihood strategies and their impact on agricultural diversification, we code the difference between the current and base period values of the agricultural diversification index as reduced, unchanged or increased, corresponding to values 1, 2 and 3, respectively.

The independent variable considered in this paper is the change in farmer livelihood strategy, coded with values 1, 2, 3, 4 and 5.

Since changes in farmers' livelihood strategies may have heterogeneous effects on agricultural diversification in different regions, this paper divides the study regions into the eastern, central and western regions, with assigned values of 1, 2 and 3, respectively. The specific variable assignments are shown in Table 2.

Table 2. Variable definitions and settings.

Variable Type	Variable Name and Code	Variable Setting
Dependent variable	Agricultural diversity index (Y)	A decrease in the agricultural diversification index is assigned value 1
		No change in the agricultural diversification index is assigned value 2
		An increase in the agricultural diversification index is assigned value 3
Independent variables	Types of changes in household livelihood strategies (SJCL)	No change in agricultural livelihood is assigned value 1
		No change in part-time agricultural livelihood is assigned value 2
		No change in a nonagricultural livelihood is assigned value 3
		A change to an agricultural livelihood is assigned value 4
		A change to an off-farm livelihood is assigned value 5
	Regional types (AR)	The eastern region is assigned value 1
		The central region is assigned value 2
		The western region is assigned value 3

3.2. Research Methods

3.2.1. Markov Chain

　　A Markov chain is an important method for analyzing changes in farmers' livelihood strategies from the perspective of structural changes. Its principle is as follows: if the livelihood strategies of the farmers studied in each year are of a possible type, then the probability distribution of the livelihood strategies of the farmers in year *t* can be represented by a state probability vector of $1 \times k$, and the probability of transfer between the livelihood strategies of farmers in different years can be expressed as a $k \times k$ matrix *P*, which is expressed as follows.

$$P = \begin{bmatrix} P_{11}(d) & P_{12}(d) \ldots & P_{1j}(d) & \ldots & P_{1k}(d) \\ P_{21}(d) & P_{22}(d) \ldots & P_{2j}(d) & \ldots & P_{2k}(d) \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ P_{k1}(d) & P_{k2}(d) \ldots & P_{kj}(d) & \ldots & P_{kk}(d) \end{bmatrix} \tag{3}$$

$$P_{ij}(d) = \frac{n_{ij}(d)}{n_i} \tag{4}$$

$$0 \leq P_{ij}(d) \leq 1 \tag{5}$$

$$\sum_{j=1}^{k} P_{ij}(d) = 1 \tag{6}$$

　　In Equations (3) and (4), $P_{ij}(d)$ represents the probability that the livelihood strategy of a peasant household is *i* at a certain time and transitions to *j* after time *d*, and $n_{ij}(d)$ represents the sum of the number of peasant households whose livelihood strategy is *i* at a certain time but transitions to *j* after time *d*. n_i represents the sum of the number of rural families relying on livelihood strategy *i* in the four years of the whole research period. At the same time, the matrix meets the two criteria associated with Equations (5) and (6); that is, the probability of a change in one livelihood strategy to another livelihood strategy is between 0 and 1, and the sum of the probabilities of a change in livelihood strategy for all livelihood strategies is 1. For example, if a peasant household's livelihood strategy in 2012 is agriculture-oriented, the sum of probabilities of choosing an agriculture-oriented part-time agricultural or nonagricultural strategy in 2014 is equal to 1.

3.2.2. Model Setting

(1)   Multiple logit model

According to the data type, the dependent variable, agricultural diversification, is an ordered multiclass classification variable. We first consider using the ordered logit model to explore the impact of farmers' livelihood strategy changes on agricultural diversification. In a parallel trends test of the original data, it is found that the *p*-value is less than 0.05, and the null hypothesis of no correlation is rejected, so the model is invalid. Therefore, this paper uses multiple logit regression models for empirical analysis. The general expression of the multiple logit model is as follows: for $j = 1, 2 \ldots J$, if the option of class J is set as the reference group, the probability ratio of the occurrence of the remaining class $J - 1$ can be expressed in the logit form of Equation (7) as follows:

$$ln\left(\frac{p(y = j\mathrm{x})}{p(y = J\mathrm{x})}\right) = \alpha_j + \sum_{j=1}^{k} \beta_{ij} X_i \tag{7}$$

$$i \in [1, k], \ j \in [1, J - 1]$$

where *j* indicates a decrease, no change or an increase, and the reference term J = increase. k is the number of explanatory variables, $1 \leq k \leq 5$, and x_i is the explanatory variable, $i = 1, 2, 3, \ldots 8$.

(2)   Fixed effect model

To explore the lagged effect of farmers' livelihood strategy changes on agricultural diversification, this paper constructed the following panel data model:

$$Y_t = \alpha + \beta_1 SJCL1_{t-i} + \beta_2 SJCL2_{t-i} + \beta_3 SJCL3_{t-i} + \beta_4 SJCL4_{t-i} + \beta_5 SJCL5_{t-i} + \varepsilon \tag{8}$$

where *t* represents the number of periods (four tracking periods from 2012 to 2018), and *i* represents the number of periods ($i = 0, 1, 2$) in which the independent variable lags behind. SJCL1–5 represents five types of livelihood strategy change. This model examines the correlation between agricultural diversification in phase *t* and changes in livelihood strategies of farmers in the current period, the later period and two other periods. In panel data analysis, there are two main methods: the fixed effect model and the random effect model. According to the Hausman test, the *p*-value of 0.000 indicates that the null hypothesis of the random effect model is not valid. Therefore, this paper adopts the fixed effect model to analyze the lag effect.

(3)   Quantile regression

Quantile regression is an extension of OLS and was first proposed by Koenke and Bassett [38]. It can fully reflect the relevant information of independent variables by estimating different conditional quantiles of dependent variables. Regression parameters change with different loci of dependent variables, which is conducive to a more detailed and comprehensive analysis of the regression relationship between variables and is relatively robust [18]. In this paper, the quantile regression method was used to test the robustness. Five loci, 0.1, 0.25, 0.5, 0.75 and 0.9, were selected to establish the quantile regression model as follows:

$$Q_q(Y) = \lambda + \sum \beta_i X_{it} + \varepsilon_{it} \tag{9}$$

where $Q_q(Y)$ is the number of score values corresponding to the *q* location, X_{it} is the value of each variable in period *t*, β_i is the quantile regression coefficient, *i* is 1 to 8, λ is the constant term and ε_{it} is the random disturbance term.

3.3. Data Sources

The data in this paper are from the four CFPS waves conducted by the Chinese Institute for Social Science Surveys (ISSS) of Peking University from 2012 to 2018. This project adopts the tracking survey method to collect data at three levels: from individuals,

families and communities. The CFPS sample is a multistage equal probability sample extracted by the implicit stratification method that covers 25 provinces/cities/autonomous regions, with the population of the sampled provinces accounting for approximately 95% of the total population of China (excluding Hong Kong, Macao and Taiwan). Based on research needs, Stata 15.0 software was used to clean the tracking data for the 2012, 2014, 2016 and 2018 waves. On the basis of family FID matching, urban families were eliminated, and only rural families were retained; then, observations with missing variable information and discontinuous data across years were eliminated. When the remaining observations were combined into a balanced panel database containing the four waves of tracking data, the final result was a sample of 3659 rural households with four phases of tracking data each. Considering the influence of regional factors on agriculture, we divide the sample into eastern, central and western macro-regions based on the level of economic and social development. The eastern region covers nine provinces and cities: Fujian, Guangdong, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin and Zhejiang. The central region covers eight provinces: Anhui, Henan, Heilongjiang, Hubei, Hunan, Jilin, Jiangxi and Shanxi. The western region covers eight provinces and autonomous regions: Gansu, Guizhou, Shaanxi, Sichuan, Yunnan, Chongqing, Guangxi and Xinjiang.

4. Analysis of Empirical Results

4.1. Changes in Household Livelihood Strategies

From the perspective of the direction of change in farmers' livelihood strategies, most farmers choose to maintain their original livelihood strategies. From 2012 to 2014, 2014 to 2016 and 2016 to 2018, the proportions of households that did not change their livelihood strategies were 52.50%, 58.80% and 56.40%, respectively (Table 3). From 2012 to 2018, the number of agricultural farmers first decreased, then increased and finally decreased again; the number of nonagricultural farmers increased and then decreased before returning to an increasing trend; and the number of part-time farmers initially rose and then declined continuously in the latter waves. On the whole, farmers' livelihood strategies change frequently. In 2014, the number of agricultural farmers increased significantly, while the number of nonagricultural farmers decreased significantly. In 2018, the number of nonagricultural farmers increased significantly, while the number of agricultural and part-time farmers decreased. These trends may be related to the implementation of a targeted poverty alleviation strategy in 2014. The Ministry of Agriculture and Rural Affairs, the Poverty Alleviation Office of The State Council and other departments launched a series of rural industry poverty alleviation projects, enabling some farmers to return to the countryside to start their own businesses, thus significantly increasing the number of agriculture-oriented farmers. However, the entrepreneurial effect brought about by the policy may not have met the expectations of farmers, resulting in a new round of migrant workers and an increasing number of nonagricultural farmers. From the perspective of the speed of change in farmers' livelihood strategies, the adjustment is slow in the short term, which may be due to the strong persistence of livelihood strategies and the accumulation of livelihood results over time, such that the effects associated with the transformation of farmers' livelihood strategies manifest with a certain lag.

To facilitate further research on farmers' livelihood strategies and their relationship with agricultural diversification, based on changes in farmers' livelihood strategy types from the beginning to the end (from 2012 to 2018), we generate a livelihood strategy transition probability matrix and present the changing trend over the five defined types of changes. Table 4 shows the change types (namely, no change from agriculture, no change from part-time agriculture, no change from a nonagricultural strategy, a transition to agriculture and a transition to a nonagricultural strategy) and the proportions of each over time.

Table 3. Transition probability matrix of household livelihood strategy changes (2012–2018).

Time	Livelihood Strategy	Off-Farm Livelihood		Part-Time Agricultural Livelihood		Agricultural Livelihood		Sum	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
2012–2014	Off-farm livelihood	735	66.34	232	20.94	141	12.73	1108	30.28
	Part-time agricultural livelihood	336	39.72	335	39.60	175	20.69	846	23.12
	Agricultural livelihood	434	25.45	419	24.57	852	49.97	1705	46.60
	Sum	1505	41.13	986	26.95	1168	31.92	3659	100.00
2014–2016	Off-farm livelihood	984	65.38	311	20.66	210	13.95	1505	41.13
	Part-time agricultural livelihood	298	30.22	433	43.91	255	25.86	986	26.95
	Agricultural livelihoods	203	17.38	230	19.69	735	62.93	1168	31.92
	Sum	1485	40.58	974	26.62	1200	32.80	3659	100.00
2016–2018	Off-farm livelihood	1082	72.86	220	14.81	183	12.32	1485	40.58
	Part-time agricultural livelihood	476	48.87	301	30.90	197	20.23	974	26.62
	Agricultural livelihoods	315	26.25	203	16.92	682	56.83	1200	32.80
	Sum	1873	51.19	724	19.79	1062	29.02	3659	100.00

Table 4. Types and statistical description of changes in household livelihood strategies.

Types of Livelihood Strategies		2018		
		Off-Farm Livelihood	Part-Time Agricultural Livelihood	Agricultural Livelihood
2012	Off-farm livelihood	759	173	176
		No change in nonagricultural livelihood	Transition towards agricultural livelihood	Transition towards agricultural livelihood
	Part-time agricultural livelihood	463	208	175
		Transition towards off-farm livelihoods	No change in part-time agricultural livelihood	Transition towards agricultural livelihood
	Agricultural livelihoods	651	3432	711
		Transition towards off-farm livelihoods	Transition towards off-farm livelihoods	No change in agricultural livelihoods
Types of change in livelihood strategies	No change in agricultural livelihood	711	19.43%	
	No change in part-time agricultural livelihood	208	5.68%	
	No change in nonagricultural livelihood	759	20.74%	
	Transition towards agricultural livelihood	524	14.32%	
	Transition towards off-farm livelihoods	1457	39.82%	

4.2. Impacts of Changes in Household Livelihood Strategies on Agricultural Diversification

According to Table 5, changes in farmers' livelihood strategies and regional heterogeneity can be explained as follows:

Table 5. Parameter estimation of the model.

Agricultural Diversification Index	Decrease			No Change		
	B	Standard Error	Exp(B)	B	Standard Error	Exp(B)
No change in agricultural livelihood	0.216	0.118	1.241	0.092	0.110	1.097
No change in part-time agricultural livelihood	0.622 ***	0.192	1.862	0.643 ***	0.177	1.902
No changes in nonagricultural livelihood	−0.262 **	0.131	0.770	0.337 ***	0.102	1.401
Transition towards agricultural livelihood	0.492 ***	0.130	1.636	0.365 ***	0.121	1.441
Transition towards off-farm livelihoods	——	——	——	——	——	——
Eastern region	−0.376 ***	0.107	0.686	1.115 ***	0.099	3.050
Central region	−0.007	0.106	0.993	1.187 ***	0.103	3.277
Western region	——	——	——	——	——	——
Intercept	−0.854 ***	0.083		−1.400 ***	0.091	
Chi squared	304.250	Pseudo R^2	0.179	Nagelkerke	0.191	

Note: The *p*-value corresponding to the independent variable is less than 0.05, indicating that the independent variable has an impact on the dependent variable (relative to the comparison term), which indicates that the model is significant. ** and *** in the table represent significance at the levels of 5% and 1%, respectively.

(1)   Heterogeneity of household livelihood strategies

There was no significant difference in the agricultural diversification index among farmers who chose to maintain their agricultural livelihood. Compared with those showing an increase in the agricultural diversification index, farmers with a decrease in their agricultural diversification index were more inclined to display a persistent index decrease if they maintained either a part-time or an agriculture-oriented, full-time agricultural livelihood strategy, with these groups 1.862 and 1.636 times more likely to show such a decrease as farmers with nonagricultural-oriented livelihoods, respectively. If the livelihood strategy changes to maintain nonagricultural livelihoods, the agricultural diversification index is more inclined to increase, with this possibility being 0.77 times that of farmers with nonagricultural-oriented livelihoods. Compared with those showing an increase in their agricultural diversification index, farmers with a decrease in their index values are more inclined to see this decrease persist if their livelihood strategies change to part-time agricultural livelihoods or if they maintain a nonagricultural livelihood or an agro-oriented livelihood, with this probability being 1.902, 1.401 and 1.441 times that of the farmers moving towards off-farm livelihoods, respectively.

(2)   Regional heterogeneity

With respect to the three regions, the agricultural diversification index in the central region did not statistically significantly differ over time, but that in the eastern region was 0.686 times more likely to increase than that in the western region. Farmers in the eastern and central regions with the same agricultural diversification indices were more likely (by 3.050 times and 3.277 times, respectively) to see their index values persist than farmers in the western regions. This is consistent with the result from Han and Lin's [39] study that China's agricultural diversification index has been relatively stable. Regional differences in agricultural development are one of the important reasons for changes in regional agricultural diversification index values. As agricultural production in the eastern region shifts from traditional subsistence crops to modern high value-added cash crops, the share of these crops in total agricultural output increases and with it the region index of agricultural diversification. However, traditional agriculture continues to occupy a dominant position in the rural western region. To seek higher economic returns, traditional agricultural cultivation in this region has shifted from single to mixed crops. Therefore, the agricultural diversification index in western China is also expected to increase. In addition, the central region has an agricultural resource advantage and development on the basis of large-scale specialized production, with the leading commercial production industry; this leads to both greater agricultural production in the central region and increases in farmers'

incomes and improves the competitiveness of regional agricultural products. Thus, the central region is more inclined to see its agricultural diversity index reduced.

4.3. The Lag Effect of Household Livelihood Strategy Changes on Agricultural Diversification

Generally, the impact of the independent variable on the dependent variable often manifests with a time lag, and the dependent variable itself is also defined by the dependency of the change in the current period on the selection of the past period. This phenomenon of the dependent variable being affected by past values of itself or of the independent variable is called the hysteresis effect. In line with the above analysis, we further processed the panel data by using the fixed-effect model and Stata's lag function to obtain the first and second lags of the explanatory variables, thus forming three sample sets. The independent variable values from the early stage of each sample set were regressed on the dependent variable values for the current period. Based on the results of multiple rounds of regression, the impacts of changes in farmers' livelihood strategies on agricultural diversification in the current and later periods were obtained (Table 6).

Table 6. The lag effect of household livelihood strategy changes on agricultural diversification.

Variable	No Change in Agricultural Livelihoods	No Change in Part-Time Agricultural Livelihood	No Change in Nonagricultural Livelihood	Transition towards Agricultural Livelihood	Transition towards Off-Farm Livelihoods
Current period	0.078 ***	0.161 ***	0.154 ***	−0.111 ***	0.287 ***
	(2.63)	(3.40)	(4.41)	(−4.90)	(22.70)
R^2	0.003	0.018	0.009	0.015	0.106
F test	3.26	3.28	3.59	3.07	3.39
Number of observations	2844	832	3036	2096	5828
One-period lag	−0.027	−0.099 *	−0.098 ***	−0.068 **	0.015
	(−0.87)	(−1.86)	(−2.77)	(−2.15)	(0.91)
R^2	0.001	0.008	0.005	0.004	0.003
F test	3.52	3.58	4.15	2.88	3.21
Number of observations	2133	624	2277	1572	4371
Two-period lag	0.097 **	0.020	−0.142 **	−0.134 ***	0.139 ***
	(2.29)	(0.25)	(−2.51)	(−2.73)	(6.07)
R^2	0.007	0.003	0.008	0.014	0.025
F test	2.73	3.58	2.73	2.11	2.35
Number of observations	1422	416	1518	1048	2194

Note: The numbers in parentheses are *t* values; *, ** and *** represent significance at the levels of 10%, 5% and 1%, respectively.

First, this paper observed the impact of changes in farmers' livelihood strategies on agricultural diversification in the current period. All five types of livelihood strategy changes showed significant effects at the 1% level. In general, livelihood strategy changes had a significant impact on agricultural diversification in the current period, with four of the five types of changes having significant positive effects. Second, this paper observed the impact of livelihood strategy changes on agricultural diversification in the first lagged period. Only three of the five variables were significant, displaying a negative correlation and a decreased significance level relative to that of the baseline results. In general, changes in farmers' livelihood strategies reduced agricultural diversification in this lagged phase to some extent. Finally, we observed the impact of changes in farmers' livelihood strategies at two lag periods. Compared with the results at one lag period, the significance of the explanatory variables increased, and the coefficients of more variables became positive. This indicated that when there was a lag of two periods, the impact of changes in farmers' livelihood strategies on agricultural diversification was enhanced. In general, livelihood strategy changes had a significant impact on agricultural diversification in this period.

In conclusion, changes in household livelihood strategies have a lag effect on agricultural diversification. Specifically, the effect at the first lag is reduced, while the effect at the second lag is significant. From the perspective of impact magnitude, the lagged effect of livelihood strategy changes on agricultural diversification first decreases and then increases. In terms of the direction of influence, the significant positive correlation

in the current period changes to a negative correlation in the first lag period but becomes positive again in the second lag period. The main reason for this result may be that most rational farmers choose livelihood strategies based on the livelihood capital they have at present and then diversify their agricultural planting, such that the livelihood strategy decisions of farmers in the current period have a significant contemporaneous impact on agricultural diversification. However, there is strong persistence in farmers' livelihood strategies, and an incomplete or delayed understanding of the livelihood capital available or of agricultural policies prolongs or hinders the process of information transmission, which weakens the positive effect of livelihood strategy changes on agricultural diversification in the first lag period. Over time, this information problem is gradually ameliorated, and farmers' choices on the basis of family endowments and livelihood results become better informed, which tends to increase the positive effect of farmers' livelihood strategy changes on agricultural diversification.

5. Robustness Test

Our estimates may be subject to errors from the measurement of the agricultural diversification index with classification variables [40]. For example, from 2012 to 2018, if the agricultural diversification index of one peasant household changed from 0.1 to 0.9 and that of another peasant household changed from 0.1 to 0.2, both households were classified as showing an increase in their index values, but there were significant differences in the agricultural diversification structures of these two peasant households. Therefore, this paper takes the specific value of change in the agricultural diversification index as an independent variable to conduct the regression analysis again.

According to Table 7, the impact on the agricultural diversification index of the same explanatory variable at different quantiles varies greatly. Using farmers who chose a nonagricultural livelihood as the reference group, farmers who chose to maintain an agricultural or a part-time agricultural livelihood had a negative impact on diversification at all quantiles. Quantiles 0.75 and 0.9 showed a significant negative impact, but the impact at quantiles 0.1, 0.25 and 0.5 did not pass the significance test. For farmers who chose to maintain nonagricultural livelihoods, the impact was significant at 0.01 at quantiles 0.1 and 0.9, with the coefficient first decreasing, then increasing, and again decreasing, indicating that when the variation range of the agricultural diversification index reached 0.1, the impact of choosing to maintain a nonagricultural livelihood on the agricultural diversification index reached its maximum. Transitioning towards an agricultural livelihood showed significant negative effects at quantiles 0.1, 0.75 and 0.9 but failed to pass the significance test at quantiles 0.25 and 0.5. Using the western region as the reference item, the eastern region showed a significant effect at the 0.01 level at quantiles 0.1, 0.5, 0.75 and 0.9, with positive effects at quantiles 0.1, 0.75 and 0.9 and a negative effect at quantile 0.5. The central region showed a significant effect at the 0.01 level at quantiles 0.1, 0.5 and 0.9, with positive effects at quantiles 0.1 and 0.9 and a negative effect at quantile 0.5. Therefore, the types of changes in farmers' livelihood strategies and regional factors affected farmers' agricultural diversification levels, with the quantile regression verifying the robustness of the multiple logit model results.

Table 7. Quantile regression of the agricultural diversification index on changes in household livelihood strategies.

Types of Household Livelihood Strategy Changes	*q* = 0.1 Coefficient	*q* = 0.25 Coefficient	*q* = 0.5 Coefficient	*q* = 0.75 Coefficient	*q* = 0.9 Coefficient
No change in agricultural livelihood	−0.024 (0.029)	−0.000 (0.004)	−0.000 (0.025)	−0.127 *** (0.042)	−0.000 *** (0.000)
No change in part-time agricultural livelihood	−0.054 (0.047)	−0.010 (0.006)	−0.000 (0.041)	−0.519 *** (0.067)	−0.055 *** (0.000)
No change in nonagricultural livelihood	0.122 *** (0.029)	0.000 (0.004)	−0.000 (0.025)	0.067 (0.041)	0.000 *** (0.000)
Transition towards agricultural livelihood	−0.089 *** (0.033)	−0.000 (0.004)	−0.000 (0.028)	−0.180 *** (0.046)	−0.000 *** (0.000)
Transition towards off-farm livelihood	——	——	——	——	——
Eastern region	0.164 *** (0.025)	0.005 (0.003)	−0.106 *** (0.022)	0.184 *** (0.036)	0.000 *** (0.000)
Central region	0.077 *** (0.026)	0.005 (0.004)	−0.106 *** (0.023)	0.042 (0.037)	0.000 *** (0.000)
Western region	——	——	——	——	——
Mean absolute error (MAE)	0.521	0.381	0.377	0.559	0.746

Note: Robust standard errors in parentheses; *** represent significance at the levels of 1%.

6. Discussion

Although different types of livelihood strategy changes have different impacts on agricultural diversification, it is worth further considering whether agricultural diversification truly meets farmers' expectations and improves farmers' production efficiency. Existing studies have found that China's agricultural production has an obvious labor-saving tendency [41] and that agricultural diversification is not conducive to the improvement of farmers' livelihoods. Chinese agriculture is trending towards large-scale and specialized development; however, if farmers' management ability is deficient, a strategy of agricultural diversification will inevitably lead to deviation from optimal factor allocation, resulting in losses of production efficiency. This means that when the diversification of planting is at a low level, farmers can neither improve the production efficiency of a single crop through specialized production nor leverage the economic advantages of a range of crops through mixed management, giving rise to a dilemma between specialization and diversification and leading to an overall efficiency loss. Under rationalized management, agricultural diversification positively impacts agricultural technical efficiency, agricultural resource use and environmental outcomes [42]. Agricultural policy departments should try their best to provide farmers with agricultural information and credit support and actively assist those who choose to maintain nonagricultural livelihoods in carrying out crop diversification.

The development of world agriculture has tended towards greater intensiveness, specialization, scale and mechanization [43,44]. China's agricultural development is no exception, and it is necessary to encourage the development of intermediate-scale agricultural operations on the premise of maintaining an appropriate level of diversification [45]. To develop agricultural operations at this scale, farmers' livelihood strategies must be correspondingly adjusted, investment in the agricultural industry in rural areas should be increased, agricultural industry projects should be invigorated, agricultural industrialization should be promoted, the quality and stock of rural capital should be strengthened and farmers should be guided in adjusting their livelihoods in an orderly way. Second, farmers should be encouraged to participate in land circulation by shifting peasant household land management rights toward large circulation cultivation, expanding new agricultural management bodies, promoting mechanization and agricultural production and operation at a moderate scale, liberating farmers from small-scale peasant production and encouraging farmers to transition towards nonagricultural livelihoods that can improve their livelihood results. Finally, farmers' ability to shift to a nonagricultural livelihood strategy should be enhanced. Vocational skills training should be strengthened for farmers, livelihood skills should be improved and diversified employment opportunities should be increased.

The influence of livelihood strategy changes on agricultural diversification in China can be used as a reference for developing countries. First, the pull effect of industrialization and urbanization on the rural surplus labor force is the premise of the change in farmers' livelihood strategies [46]. Therefore, developing countries should also focus on coordinating industrial restructuring and urbanization and making the forward guidance on changes in livelihood strategies in the process of farmers' transfer. Second, land circulation is one type of natural capital used to realize farmers' livelihood. By encouraging land operation and circulation, natural capital can be optimized and the land circulation system can be improved to provide land policy guarantees for farmers' livelihood transformations. Third, the government should promote the development of rural finance, increase the support of financial institutions for farmers through formal channels, encourage financial institutions to conduct innovative research on rural mortgage products and improve the financing capacity of farmers. Only when the livelihood problems of farmers are solved can the livelihood strategies of farmers be transformed. The transformations of farmers' livelihood strategies enable moderate-scale operations in agricultural development, which can improve the specialization and mechanization of agriculture.

The farmers who earn CNY 3676~10,000 per year from agricultural enterprise are defined as "moderate scale" in this study. According to the case study of Henan province in China, the moderate scale of grain planting is 2.85~4.44 ha. If agricultural workers are hired, the size can be up to 8.87 ha [47]. Other studies have proposed moderate-scale standards, such as 1.34~3.35 ha [48], 3.35~4.69 ha [49], 0.67~6.7 ha [50]. It is about 2.01~4.02 ha in the south and 4.02~8.04 ha in the north [51], 6.7 ha [52] and 9.65 ha [53]. Therefore, moderate scale is a relative concept.

Based on data from the China Household Tracking Survey, the Herfindahl index was adopted to measure agricultural diversification. However, in this paper, agricultural diversification products were divided into the categories of agricultural and forestry products, as well as livestock and aquatic products. Data limitations may have caused relatively large internal differences in the values of the agricultural diversification index, affecting the classification of agricultural diversification in later periods and further improvements to the index are thus needed in future studies. In addition, both farmers' livelihood strategy changes and agricultural development are affected by agricultural policies, but in this study, given restricted data availability, the model did not consider how agricultural policies in different periods and regions shaped changes in farmers' livelihood strategies and affected agricultural diversification, which should be considered in future studies. The choice between macro-data and micro-data was a dilemma. Although macro-data were relatively easy to obtain, they could not deeply explain the internal mechanism of the impacts on agricultural diversification resulting from changes in farmers' livelihood strategies; additionally, the impacts on agricultural planting resulting from changes in farmers' livelihood strategies should be studied with more micro-data. CFPS is a national, large-scale and multidisciplinary social micro-tracking survey with a sample size of 16,000 households, including the livelihood change module of farmers and their agricultural operation conditions, which thoroughly meet the needs of this study.

7. Conclusions

Based on four waves of CFPS tracking data, a Markov transition probability matrix was used to explore farmers' livelihood strategy changes, and a multivariate logit model and a fixed-effect model were built. The impact of farmer livelihood strategy changes on agricultural diversification and the hysteresis effect were examined in the empirical analysis. The results showed that (1) farmers' livelihood strategy decisions were strongly persistent. Regarding the speed of change, the adjustment of livelihood strategies was slow, with most farmers choosing to maintain their original livelihood strategy in the short term. (2) Different types of livelihood strategy changes had different impacts on agricultural diversification. Compared with households showing an increase in their agricultural diversification index, households showing a decrease in the index were more inclined to show

a persistent decrease if they chose to maintain a part-time or full-time agriculture-oriented livelihood. If households chose to maintain nonagricultural livelihoods, the agricultural diversification index tended to increase. Households with unchanged agricultural diversification index values were more inclined to remain persistently unchanged in these values if they chose to maintain a part-time, agro-oriented livelihood or nonagricultural livelihood. (3) The impact of livelihood strategy changes on agricultural diversification showed regional heterogeneity. Compared with households showing an increase in their agricultural diversification index, farmers in the central region with a decreased agricultural diversification index showed no statistically significant change, but that of farmers in the eastern region tended to increase. Farmers in the eastern and central regions with an unchanged agricultural diversification index were more inclined to show persistent stasis. (4) The effect of household livelihood strategy changes on agricultural diversification manifested with a lag. This impact decreased at a lag of one period but significantly increased at a lag of two periods. From the perspective of impact magnitude, the lagged effect of livelihood strategy changes on agricultural diversification first decreased and then increased. In terms of the direction of influence, the significant positive correlation in the current period changed to a negative correlation in the lag period but again became positive in the second lag period.

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