# Optimal decision making by farmer households: nonfarm employment quality and agricultural production investment flexibility

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## Abstract

Investment in agriculture is crucial to increasing agricultural production capacity and income. The importance of public investment in agricultural investment has always been significant. However, it is also vital to encourage farmers' private investment in agriculture for agricultural expansion to be sustainable. In recent decades, the nonfarm sector has expanded dramatically, and farmers' nonfarm employment has steadily become one of the primary sources of income for farm households. Therefore, Does the quality of farmers' nonfarm employment affect investment in agricultural production? Is it a disincentive or an incentive? Using data from the 2012 China Family Panel Studies (CFPS), this study examines the effect of farmers' nonfarm employment quality on agricultural investment. The results indicate that an improvement in the quality of nonfarm employment can enhance flexible investment in agricultural production but has no appreciable impact on fixed investment in agricultural production. In reality, the improved quality of nonfarm employment encourages agricultural production services in place of agricultural labor and machinery.

**Keywords:** Nonfarm employment. Flexible investment. Agricultural production.

## 1. Introduction

How to encourage investments in small-scale agriculture that increase productivity is a long-term challenge in development economics. Investment in agriculture improves agricultural production conditions, boosts agriculture's overall productivity, and is a crucial means of boosting farmer incomes(TOM, H, 2009). Although the Food and Agriculture Organization says that agricultural investment rates are on the rise, particularly in North America and Europe, growth has been steady and higher than in low-income and middle-

income countries. Nonetheless, agricultural production necessitates colossal investments, innovative production models, and intelligent technologies to increase productivity and efficiency(COSCULLUELAMARTÍNEZ, C, et al., 2021). Public investment in agriculture focuses mostly on investments in agricultural fixed assets, such as lands, meteorology, water resources, and major agricultural equipment and machinery(NUSRAT, A, et al., 2019). Specifically, farmers are primarily responsible for investments in agricultural production (such as small agricultural machinery and flexible agricultural factors of production). Therefore, to continuously increase agricultural investment, it is vital to encourage farmers to invest in agriculture. Then, we examine whether the quality of farmers' nonfarm employment encourages investment in agricultural production as the trend of farmers' nonfarm employment increases.

Investments in agricultural production by farm households are frequently constrained by credit restrictions and cannot be supported through borrowing, particularly for low and middle-income farmers(YING, M, et al., 2017).In many developing countries, especially rural areas, credit and insurance markets are insufficient for farm households to invest in production and maintain a steady consumption level(JHA, B, 2010). Diversifying work sources outside agriculture is one approach to circumventing credit market limits. Non-agricultural income eases budgetary limitations, and financial flows from non-agricultural activities can offer liquidity for agricultural production(GBEMISOLA, O, et al., 2009). Non-agricultural activities may involve less uncertainty and be less connected to agricultural activities. Therefore, farmers with nonfarm employment face fewer threats to their way of life. Nonfarm employment enables to be met by a more stable income stream but also enables households to employ this diversification as an ex-ante approach to reduce income volatility(MITCH, R, 1990).

Diversification of nonfarm employment could assist farmers in low-income regions in increasing their investment in agricultural technology, thus fostering agricultural production and economic growth. Diversification of farmers' sources of income from non-agricultural activities could assist small farmers in coping with shocks and mitigating agricultural risks by eliminating mobility constraints on their investment in productivity(C., B B, et al., 2001)(BEKELE, S, et al., 2015).In contrast to other studies, it has been stated that nonfarm employment may be associated with agricultural revenue and may not provide farmers with a safety net when agricultural income is unexpectedly low(BRYAN, E, et al., 2013). Since revenue from nonfarm employment is greater than income from agriculture. It is possible for nonfarm employment to displace agricultural activities and deplete agricultural inputs.

Second, nonfarm employment may diminish the labor force involved in agricultural production and the inputs of agricultural production(ITO, T, et al., 2007). Earnings from nonfarm employment do not inevitably increase the scale of agricultural production or enhance farm efficiency(KILIC, T C C M, 2009).

Consequently, the effect of farmers' nonfarm employment on agricultural investment may have two possible consequences. On the one hand, nonfarm employment may displace farmers' labor and production factor inputs. On the other hand, farmers' income from nonfarm employment can support investment in agricultural production and boost the efficiency of agricultural production. The quality of farmers' nonfarm employment depends on their nonfarm employment participation and earnings. The effect of farmers' nonfarm employment quality on agricultural investment may have two possible results, one of which is that farmers' nonfarm employment quality encourages investment in agricultural production. On the other hand, the quality of farmers' nonfarm employment would discourage investment in agricultural production. What are the particular outcomes? Therefore, this study offers a measure of the quality of farmers' nonfarm employment in order to investigate the effect of the quality of farmers' nonfarm employment on investment in agricultural production.

Nearly one-fifth of the world's population lives in China, a country with a low level of agricultural modernization, and the ability of Chinese agriculture to feed such a huge population is a constant source of global concern. Investment is the key to the advancement of agricultural production technology, production efficiency, and the expansion of food production(KEITH, F, 2018; THOMAS, P T, et al., 2019), which makes it one of the most critical issues in China's agricultural growth. In China, the participation of farmers in nonfarm employment is common, and farmers engage in both agricultural production and nonfarm employment(SVINOUS, N, 2020). According to relevant data, in 1996, just 37.19 percent of farmers worked in both agricultural and nonfarm employment, but by 2012, that number had risen to 81.72 percent, and farmers who work only in agriculture are becoming increasingly rare in China. On the basis of the aforementioned characteristics, China is an ideal location for testing the effect of farmers' nonfarm employment quality on agricultural production investment.

Agricultural investment in China consists primarily of public investment and private investment. The public investment focuses mostly on agricultural fixed assets, including agricultural infrastructures such as cropland, meteorology, water conservation, and major agricultural machinery and equipment, but excludes fixed investment by farmers(HUANG, P M, 1990). Farmers are primarily responsible for productive agricultural inputs (e.g., small

agricultural machinery, agricultural flexible factors of production, etc.). Despite the fact that public fixed investment in agriculture has increased significantly over the past two decades, the proportion of investment in agricultural fixed assets remains low. Private investment by farmers is the primary source of investment in agricultural production. Therefore, we are more concerned with the behavior of farmers while making investments in agricultural production.

Regarding the source of agricultural investment, farmers obtain the majority of their income from farming when they are not engaged in nonfarm activities. Thus, farm earnings are invested in agricultural production. The rise of the non-agricultural sector has altered the farmers' sole source of income, and non-agricultural revenue also supports agricultural investment. This participation in nonfarm activities has resulted in a decline in the proportion of the household labor force engaged in agricultural production and a decline in the proportion of agricultural income to total household income. Due to the varying degrees and situations of nonfarm employment participation, the effects on agricultural production are variable. What effect does the quality of farmers' nonfarm employment have on agricultural production investment? This is what our study will explore.

Numerous researchers have examined the effect of nonfarm employment involvement on agricultural investment. Nonetheless, these research have not established a consensus regarding the effect of nonfarm employment on agricultural investment. In addition, it is assumed that farmers' nonfarm employment is uniform, and the quality of farmers' nonfarm employment is not examined in depth.

This study aims to address a gap in the literature about the impact of nonfarm employment quality on agricultural production investment and to draw informed conclusions regarding the impact of nonfarm employment on agricultural production investment. Further, explain the impact of the quality of farmers' nonfarm employment on fixed and flexible investment in agricultural production. To accomplish these aims, we employ data from the CFPS 2012. Ordinary Least Squares (OLS) regressions are utilized to investigate the internal causes and mechanisms behind the relationship between the quality of nonfarm employment of Chinese farmers and agricultural production investment. The Instrumental Variables(IV) model is used to address the endogeneity of the model further.

The structure of the article is as follows: A complete review of the relevant studies is presented in the second section. In the third section, based on specified definitions and models are presented. The outcomes of the model are discussed in the fourth section. In the final section, we draw conclusions.

## 2. Literature Review

A vast number of valuable research findings have been discovered on the relationship between agricultural inputs, economic growth, and productivity growth. Multiple economic models and econometric analysis studies have determined that agriculture's technological inputs are the source of total factor productivity growth and the driving force behind sustained economic expansion(WANG, T, et al., 2018). Agricultural production inputs play a crucial part in agriculture's development and productivity growth(JOSÉ, G, et al., 2016). Through his research, Li Zhou determined that the impact of agricultural input growth on agricultural output growth was 40.6%, with fertilizer inputs contributing the most to output growth, followed by machinery inputs(LI, Z, et al., 2013). A rise in agricultural inputs corresponds to a rise in agricultural investment. The primary source of agricultural investment is farmers themselves, followed by public investment from the government(2015). Agricultural revenue and non-agricultural income are related to farmers' sources of investment in agricultural production. In recent decades, agricultural labor productivity in developing countries has increased due to the increased rate of nonfarm employment among farmers(KEITH, O F, 2018).

Participation in nonfarm employment is an alternative for farmers seeking to maximize household income. Income is a critical factor determining farmers' participation in non-agricultural activities. Farmers are rational in economics and compatible with the behavioral objective of profit maximization(MADAKI, J U, et al., 2014). Nonfarm employment promotes the maximization of household returns and the minimization of risk, whether in terms of nonfarm employment returns, nonfarm employment opportunities, or household nonfarm employment demographic factors. Thus, under the assumption of profit maximization for farmers, farmers choose between nonfarm employment and agriculture and are more likely to prefer nonfarm employment(HUANG, J, et al., 2012). The path of influence stems from the improvement of factor endowment by nonfarm employment(MWADIME, R, et al., 1996), which generates a comparison of returns by measuring the relative advantages of agriculture and nonfarm, and the decision to maximize welfare triggers a shift in investment in agriculture. If necessary, farmers may gradually reduce their agricultural investment until they leave the industry(KHAN, W, et al., 2017).

Employment outside of agriculture stimulates investment in agricultural production. Scott attributes morality to the behavioral judgments made by agricultural households. In times of situational uncertainty, it is argued that farmers favor risk aversion over gain, even if

this choice results in reduced returns(SCOTT, J C, 1987). The theory that farmers choose risk aversion would have two channels of beneficial benefits for agricultural investment if seen from a risk perspective. First, agricultural production is the most fundamental source of revenue for farm households in order to produce enough food for consumption. Farm households shift their labor to nonfarm employment and will inevitably increase their capital investment to achieve labor substitution in agriculture. Second, due to the restriction on household registration, nonfarm employment does not guarantee farmers a steady source of income and the same level of social security as farmers. Farming households continue to rely on farmland as an investment in stability and social security, and they are compelled to boost their agricultural investments(SHENGGEN, F, et al., 2004).

The quality of farmers' nonfarm employment on the behavioral decisions of farm households. According to Todaro's expected income differential theory, farmers' nonfarm employment decisions are influenced by their expectations of urban-rural income disparities. This expectation incorporates both income and employment probability(HARRIS, J R, et al., 1970). Moreover, according to the new migratory economics theory, farm households' behavioral decisions are founded on joint household decisions(STARK, O, 1979; STARK, O, et al., 1990). Households engage in internal labor division to maximize projected income and reduce risk. Along with the changes in rural institutions and market-oriented reforms, the nonfarm activities of Chinese farmers evolved, increasingly diverging from agricultural production into the city and occupying a substantial portion of the urban labor market for a considerable amount of time(A., G, et al., 1978). Due to the restriction on household registration status, the rural population has historically received "different remuneration for the same labor" compared to the urban population(CHEN, J, 1994). Simultaneously, the welfare protection system of urban employment is very different from that of rural employment, and the treatment of farmers' work will have a significant impact on their behavioral choices after they transfer to employment, which will lead to different investment behaviors among farmers involved in nonfarm employment.

Farmers' quality of nonfarm employment has multiple effects on agricultural production investment. Academic consensus has emerged regarding the extensive nature and multidimensionality of the employment quality metric(CLARK, A E, 2005). The quality of nonfarm employment includes wages, working hours, social security, and employment stability(ERHEL, C, et al., 2014). In the study of the effect of nonfarm employment wages on investment in agricultural production, the purpose of nonfarm employment for farmers is economic gain, and nonfarm employment consumes the home labor force utilized for

agricultural production. This alters the structure of agricultural production elements in the farm household, necessitating a reallocation of production components. To accomplish labor substitution, agricultural households will increase their capital inputs. If sustained nonfarm employment has a reliable source of income(de BUSTILLO RAFAEL, M, et al., 2011), it reduces the household's sustenance risk and motivates farmers to invest in agriculture for higher returns. In addition, farmers desire social security, such as the protection and welfare of the labor force employed in nonfarming occupations(GREEN, F, 2013). If farmers participate in social security through nonfarm employment, the pension security function of agricultural land is reduced, and farmers may lower their agricultural investment. Nonfarm employment quality influences the uncertainty of farmers' agricultural investment because the components of nonfarm employment quality: wages, working hours, social security, and employment stability each have a distinct impact on farmers' agricultural investment.

In conclusion, the studies that have been undertaken on the effect of nonfarm employment on farmers' investment in agricultural production have yielded contradictory and inconsistent results. What these studies have in common is the assumption that farmers have the same quality of nonfarm employment when, in reality, wages, working hours, social security, and employment stability vary greatly. Different levels of employment quality will have significant effects on the agricultural investment decisions of farmers. We examine the influence of farmers' nonfarm employment quality on changes in agricultural investment by combining four characteristics of nonfarm employment quality: wages, working hours, social security, and employment stability.

Based on the current research, the major contribution of this study consists of the following. Construct a measure of the quality of farmers' employment, using wages, working hours, employment stability, and social security. Due to variances in results produced by the various usages of nonfarm employment variables, this research explores the consistency of the study's findings by assessing the impact of farmers' nonfarm employment quality on agricultural production investment. To investigate the causes of effects of farmers' employment quality on agricultural production investment and to fill gaps in the current literature.

## 3. Materials and Methods

### 3.1. Research region and sample

Our study utilized data from the China Family Panel Studies (CFPS), a micro database operated by Peking University, China. This survey of data represents the multifaceted changes in Chinese society by monitoring three levels: the individual, the household, and the community. The data was collected using a multistage stratified indicator ranked sampling technique, and the questionnaire includes social, economic, educational, health, psychological, and demographic factors. This sample is extremely representative, as it includes 25 provinces (municipalities and autonomous areas) that account for more than 90 percent of China's total population. For the purposes of the study and the availability of data variables, only CFPS 2012 data have been chosen for the empirical section of this work, and the paper matches the two databases of farm household data and household data. After deleting samples with significant flaws, only samples of farm households' heads were maintained, and the final sample of 5631 farmers' households information was acquired.

### 3.2. Setting the variables

Farmers' agricultural production investment. Farmers prefer to use factor-saving investments, which can be divided into two categories: labor-saving and land-saving investments. Labor-saving investment is from the perspective of labor-saving by increasing investment in machinery to replace labor. Land-saving investment refers to substituting the land factor by increasing the input of fertilizers, pesticides, and other factors to offset the scarcity of the land factor(GIBSON, M A, et al., 2012; MARRIT, V, et al., 2007). Accordingly, this paper divides agricultural production investment into flexible investment related to land factor saving (including inputs of fertilizers, pesticides, and seeds) and fixed asset investment related to labor-saving investment (mainly referring to agricultural machinery inputs of farmers) (JASON, D, et al., 2014). Among them, flexible agricultural investment is expressed using the total inputs of fertilizer, pesticides, and seeds and is logarithmically treated. Agricultural mechanization input is selected as farmers' total tractor purchase expenditure and taken as a logarithm. Also, there is an indicator of farmers' production service investment. This indicator is mostly a logarithmic sum of the costs of renting, processing, and transporting farm equipment used last year.

The quality of farmers' nonfarm employment, a comprehensive measure. The objective measurement model of employment quality is used to select the four sub-indicators of wages (monthly wage), weekly working hours (number of hours), employment stability (whether or not they worked last week), and social security (whether or not they worked with

"five insurance and one fund") to calculate the employment quality index in this paper(ERHEL, C, GUERGOAT-LARIVIÈRE, M, LESCHKE, J and WATT, A, 2014). The specific computation procedure is outlined below.

Each sub-indicator was first standardized as follows:

$$x_{ij}^{nor} = \frac{x_{ij} - min_j}{max_j - min_j} \quad (1)$$

Where $x_{ij}^{nor}$ denotes the result of table transformation of the indicator, $i$ represents each sample, and $j$ denotes each measured sub-indicator. $max_j$ is the maximum value in each sub-indicator, and $min_j$ is the minimum value. Also, since working hours change opposite to the quality of employment, unit 1 minus the standardized value is used as a measure of time worked.

Second, the equal-weighted average method was used to measure the quality of employment index for farmers' nonfarm employment $Q_i$.

$$Q_i = \frac{1}{4} * \sum_{j=1}^{4} x_{ij} * 100 \quad (2)$$

Finally, the employment quality index $Q_i$ is calculated by substituting the values (see Table 1).

The farmers' nonfarm employment optimism. The degree of optimism in nonfarm employment is used in the model as a proxy variable for the quality of farmers' nonfarm employment index. It is perceived by employment farmers as the opposite of the severity of employment and has a value of 0-10, with higher values indicating more optimism about the employment situation.

Demographic variables. Farmers reported their household head, demographic, economic, and geographical environment characteristics. Household head characteristics: age, education level, and health level were mainly selected. Household demographic characteristics were selected as the household size, the proportion of females in the household, and the household dependency ratio(JI, Y, et al., 2012). Household economic characteristics were selected to describe the area of land owned by the household, the value of land assets, and the value of household financial assets and non-housing financial liabilities(JIKUN, et al., 2009). Geographical environment characteristics were selected to describe village geographical characteristics and village economic status (XIANLEI, M, et al., 2015). The definition of variables and descriptive statistics are shown in Table 1.

**Table 1: Descriptive statistics of variables.**

| Variable Name | Description | Average | S.E. |
|---|---|---|---|

| | | Value | |
|---|---|---|---|
| Flexible investments | Total fertilizer, pesticide, and seed inputs (log) | 7.346 | 1.123 |
| Fixed Asset Investment | Total household spending on tractor ownership purchases(logarithmic) | 2.978 | 3.667 |
| Agricultural production services investment | Total spending on farm machinery rental, processing, transportation (logarithmic) | 3.440 | 3.182 |
| Nonfarm employment ratio | Nonfarm employment labor force as a percentage of household labor forceb | 14.81 | 19.74 |
| Quality of nonfarm employment | Quality of nonfarm employment of farmers Composite calculated value of employment index (0-100) | 40.22 | 17.51 |
| Wages | Monthly wages (yuan) | 1.911 | 2.818 |
| Working hours | Weekly working hours (hours) | 14.32 | 26.63 |
| Social security | Whether there is "five insurance and one pension", "yes" = 1; "no" = 0 | 0.060 | 0.238 |
| Employment stability | Did you work last week, "Yes" = 1; "No" = 0 | 0.829 | 0.377 |
| Number of nonfarm jobs | Number of farmers working in nonfarm jobs | 0.257 | 0.533 |
| Age | Age of head of household | 50.02 | 11.37 |
| Education | Number of years of education for the head of household (years) | 6.473 | 3.997 |
| Health | The health of the head of household is assigned a value of 1-5 from low to high, respectively. | 2.751 | 1.219 |
| Percentage of women | Women as a percentage of total household size | 0.511 | 0.184 |
| Household size | Number of household members living together | 4.338 | 1.792 |
| Household dependency ratio | Population under 16 and over 70 years of age/total labor force | 0.399 | 0.505 |
| Arable land area | Area of collective land owned plus area transferred in minus area transferred out | 20.20 | 34.26 |
| Land Assets | Value of household land assets(logarithm) | 9.982 | 1.347 |
| Financial Assets | Value of financial assets held by households (logarithm) | 7.926 | 2.537 |
| Financial liabilities | Household non-mortgage financial liabilities (log) | 2.984 | 4.519 |
| Plain | Whether the village landscape is plain "yes" = 1; "no" = 2 (mountainous area is the control) | 0.380 | 0.485 |
| Hilly | Whether the village landscape is hilly "yes" = 1; "no" = 2 (mountainous area is the control) | 0.346 | 0.476 |
| Village Economy | Village economic status is assigned a value of 1-5 from low to high | 3.805 | 1.249 |

### 3.3. Analysis of regression

A regression analysis model was utilized to study the impact of the quality of farmers' nonfarm employment on agricultural production investment. The following was established as the regression model's baseline.

$$Y_i = \alpha_0 + \alpha_1 X_i + \alpha_2 D_i + \varepsilon_i \quad (3)$$

Where $Y_i$ represents agricultural production investment by farm households, broken down into fixed asset investment and flexible investment. $X_i$ indicates the quality of nonfarm employment by farmers. $D_i$ denotes the control variable, which is a matrix of all important

control factors encompassing variables at four levels: head characteristics, demographic characteristics, economic characteristics, and geographic environment characteristics. $\alpha_0$ is a constant term, while $\alpha_1$ and $\alpha_2$ are estimable parameters. It is assumed that the random error term $\varepsilon_i$ satisfies the normal distribution assumption.

## 4. Results

### 4.1. Impact of the quality of farmers' nonfarm employment on investment in agricultural production

Based on the model built in the preceding section, regressions were conducted using Stata 15.1 software, and the results of the regressions are shown in Table 2.

**Table 2: Baseline regression results of the quality of farmers' nonfarm employment and farm household investment in agricultural production.**

| Variable Name | Flexible investments | | Fixed Asset Investment | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| Quality of nonfarm employment | 0.005*** | 0.003*** | 0.002 | 0.002 |
| | -0.001 | -0.001 | -0.003 | -0.002 |
| Age | | -0.004*** | | -0.024*** |
| | | -0.001 | | -0.004 |
| Education | | 0.012*** | | 0.028** |
| | | -0.003 | | -0.011 |
| Health | | 0.013 | | 0.106*** |
| | | -0.011 | | -0.037 |
| Percentage of women | | 0.121* | | -0.136 |
| | | -0.069 | | -0.239 |
| Household size | | 0.026*** | | 0.112*** |
| | | -0.007 | | -0.025 |
| Household dependency ratio | | -0.048* | | -0.223** |
| | | -0.026 | | -0.09 |
| Arable land area | | 0.003*** | | 0.007*** |
| | | 0 | | -0.001 |
| Land Assets | | 0.422*** | | 0.400*** |
| | | -0.009 | | -0.033 |
| Financial Assets | | -0.005 | | 0.066*** |
| | | -0.005 | | -0.018 |

| | | | | | |
|---|---|---|---|---|---|
| Financial liabilities | | 0.009*** | | 0.009 | Note: *, **, and *** represent significant at the 10%, 5%, and 1% statistical levels, respectively; robust standard errors are in parentheses. |
| | | -0.003 | | -0.01 | |
| Plain | | 0.369*** | | 1.151*** | |
| | | -0.032 | | -0.111 | |
| Hilly | | 0.080** | | 0.335*** | |
| | | -0.032 | | -0.11 | |
| Village Economy | | 0.015 | | -0.178*** | |
| | | -0.01 | | -0.036 | |
| Constant | 7.135*** | 2.708*** | 1.564*** | -2.578*** | |
| | -0.037 | -0.136 | -0.11 | -0.475 | |
| Observations | 5631 | 5502 | 5631 | 5502 | |

In Table 2, Model 1 and Model 2 represent the effects of nonfarm employment quality on flexible agricultural investment. Model 1 does not include control factors, but Model 2 includes control variables. It is evident that the outcomes of Models 1 and 2 are consistent. At a significance level of 1%, the quality of nonfarm employment of farmers has a beneficial impact on the flexible investment in agricultural production. In Model 3, Model 4 represents the effects of nonfarm employment quality on agricultural fixed asset investment. Model 3 lacks control factors, but Model 4 has control variables. Models 3 and 4 are statistically insignificant, showing that the effect of the quality of nonfarm employment of farmers on investment in agricultural fixed assets is insignificant.

Although we control for covariates at the farmer, household, and community levels, it is necessary to conduct additional tests to evaluate the robustness of the Table 2 results. In the regressions, alternative variables are utilized. In general, a higher employment optimism for farmers' nonfarm employment indicates a higher quality of nonfarm employment. The fewer nonfarm jobs there is, the greater the farmers' dependence on farming, which also suggests a higher quality of nonfarm employment(REN, Y K, et al., 2015). Consequently, we regressed investment in agricultural production using farmers' employment optimism and the number of nonfarm jobs, and the findings are shown in Table 3.

**Table 3: Regression results of replacing key explanatory variables.**

| Variable Name | Flexible investments | | Fixed Asset Investment | |
|---|---|---|---|---|
| | Model 5 | Model 6 | Model 7 | Model 8 |
| Employment Optimism | 0.014*** | | -0.011 | |
| | -0.005 | | -0.017 | |
| Number of nonfarm jobs | | 0.081** | | 0.232 |
| | | -0.033 | | -0.142 |
| Age | -0.005*** | -0.003 | -0.025*** | -0.026** |

| | | | | |
|---|---|---|---|---|
| | -0.001 | -0.002 | -0.004 | -0.01 |
| Education | 0.011*** | 0.001 | 0.032*** | -0.009 |
| | -0.003 | -0.006 | -0.012 | -0.027 |
| Health | 0.011 | 0.03 | 0.100*** | 0.184** |
| | -0.011 | -0.019 | -0.039 | -0.082 |
| Percentage of women | 0.136* | -0.035 | -0.103 | 0.504 |
| | -0.073 | -0.123 | -0.252 | -0.529 |
| Household size | 0.025*** | 0.008 | 0.119*** | 0.143** |
| | -0.008 | -0.014 | -0.027 | -0.059 |
| Household dependency ratio | -0.050* | -0.021 | -0.240** | -0.306 |
| | -0.027 | -0.048 | -0.095 | -0.208 |
| Arable land area | 0.003*** | 0.003*** | 0.007*** | 0.003 |
| | 0 | -0.001 | -0.001 | -0.002 |
| Land Assets | 0.421*** | 0.489*** | 0.406*** | 0.475*** |
| | -0.01 | -0.018 | -0.034 | -0.078 |
| Financial Assets | -0.004 | -0.006 | 0.064*** | 0.087** |
| | -0.005 | -0.01 | -0.019 | -0.042 |
| Financial liabilities | 0.010*** | 0.007 | 0.006 | 0.041** |
| | -0.003 | -0.005 | -0.01 | -0.02 |
| Plain | 0.359*** | 0.345*** | 1.125*** | 1.200*** |
| | -0.033 | -0.055 | -0.116 | -0.238 |
| Hilly | 0.088*** | -0.110** | 0.370*** | 0.023 |
| | -0.033 | -0.055 | -0.116 | -0.236 |
| Village Economy | 0.015 | 0.007 | -0.184*** | -0.12 |
| | -0.011 | -0.017 | -0.038 | -0.074 |
| Constant | 2.815*** | 2.107*** | -2.426*** | -4.427*** |
| | -0.142 | -0.253 | -0.495 | -1.089 |
| Observations | 5122 | 1362 | 5122 | 1362 |

Note: *, **, and *** represent significant at the 10%, 5%, and 1% statistical levels, respectively; robust standard errors are in parentheses.

We introduce the instrumental variables approach to address the endogenous problem of omitted variables and reciprocal causality. Village-level variable "village nonfarm employment ratio" is the instrumental variable of nonfarm employment quality. On the one hand, a higher proportion of nonfarm employment in villages means better employment opportunities and higher wages. On the other hand, farmers do not exist independently in villages; the village nonfarm employment ratio significantly affects farmers' nonfarm employment choices, and the village nonfarm employment ratio is correlated with farmers' nonfarm employment quality(HONGQIN, C, 2011). Apart from this, the proportion of village nonfarm employment has almost no relationship with individual farmers' investment in agricultural production, in line with the assumption of exogenous instrumental(REN, M, et al., 2009).

Further tests are needed to illustrate the instrumental variables' validity. First, the test for weak instrumental variables was conducted, and the regression results of the first stage showed an F-value of 15.16, a rule of thumb is that the selected variable can be rejected as a weak instrumental variable as long as the F-statistic of the test is greater than 10. Secondly, in the correlation test between the instrumental and the endogenous variables, the first stage

regression results show a regression coefficient of 0.171 and significant at the 1% level, which satisfies the assumption of correlation between the two. Finally, the use of instrumental variables presupposes the existence of endogenous explanatory variables, and the Hausman test accounts for the explanatory variables' endogeneity. The results show that the original hypothesis that the explanatory variables are exogenous is rejected at the 1% significance level. Therefore, the use of the instrumental variable "village nonfarm employment ratio" is feasible. The regression results are presented in Table 4.

**Table 4: Instrumental variables regression.**

| Variable Name | Flexible investments | | Fixed Asset Investment | |
|---|---|---|---|---|
| | 2SLS | IV--Tobit | 2SLS | IV--Tobit |
| Quality of nonfarm employment | 0.115*** | 0.115*** | 0.039 | 0.207 |
| | -0.032 | -0.031 | -0.046 | -0.234 |
| Age | -0.023*** | -0.023*** | -0.029*** | -0.150*** |
| | -0.006 | -0.006 | -0.009 | -0.044 |
| Education | 0.020** | 0.020** | 0.031*** | 0.153** |
| | -0.008 | -0.008 | -0.012 | -0.062 |
| Health | 0.025 | 0.025 | 0.116*** | 0.526*** |
| | -0.025 | -0.026 | -0.039 | -0.19 |
| Percentage of women | 0.06 | 0.06 | -0.134 | -0.624 |
| | -0.158 | -0.166 | -0.24 | -1.263 |
| Household size | 0.016 | 0.016 | 0.102*** | 0.517*** |
| | -0.017 | -0.017 | -0.025 | -0.13 |
| Household dependency ratio | -0.096 | -0.096 | -0.237*** | -1.218** |
| | -0.059 | -0.063 | -0.087 | -0.5 |
| Arable land area | 0 | 0 | 0.006* | 0.017** |
| | -0.001 | -0.001 | -0.003 | -0.008 |
| Land Assets | 0.280*** | 0.281*** | 0.366*** | 2.267*** |
| | -0.051 | -0.046 | -0.069 | -0.375 |
| Financial Assets | 0.008 | 0.008 | 0.066*** | 0.274*** |
| | -0.013 | -0.013 | -0.019 | -0.097 |
| Financial liabilities | 0.01 | 0.01 | 0.006 | 0.026 |
| | -0.007 | -0.007 | -0.011 | -0.051 |
| Plain | 0.611*** | 0.611*** | 1.201*** | 5.689*** |
| | -0.109 | -0.106 | -0.156 | -0.818 |
| Hilly | 0.143* | 0.143* | 0.365*** | 1.824*** |
| | -0.078 | -0.08 | -0.113 | -0.627 |
| Village Economy | 0.014 | 0.014 | -0.171*** | -0.786*** |
| | -0.025 | -0.025 | -0.037 | -0.184 |
| Constant | 0.388 | 0.389 | -3.529*** | -39.528*** |
| | -0.736 | -0.712 | -1.05 | -5.549 |
| Observations | 5263 | 5263 | 5263 | 5263 |

Note: *, **, and *** represent significant at the 10%, 5%, and 1% statistical levels, respectively; robust standard errors are in parentheses.

The results in Table 4 show that the quality of nonfarm employment still positively affects flexible agricultural investment and is significant at the 1% level. This indicates that the results of the effect of nonfarm employment quality on farm households' investment in flexible assets are robust. Similarly, the effect of nonfarm employment quality on farm

households' investment in fixed assets remains insignificant, consistent with the previous results. In addition, the results are estimated using IV-Tobit regressions and are consistent with the 2SLS estimates, further illustrating the robustness of the regression results.

### 4.2. Substitution of agricultural productive services for agricultural labor

We explain the impact of the quality of farmers' nonfarm employment on agricultural investment from a different angle. The increase in the quality of nonfarm employment affects farmers' flexible investments in agricultural production. Employment outside of agriculture reduces household agricultural labor, which must be supplemented in other ways. Farmers might opt to use agricultural production services throughout the production chain as the level of agricultural production services rises. We hypothesize that agricultural production services will lead to labor substitution because there is a complementary link between the various input variables of agricultural production. Therefore, we regressed the quality of employment using the total cost of agricultural productive services, and the regression results are presented in Table 5.

**Table 5: Regression results of nonfarm employment quality and cost of agricultural production services.**

| Variable Name | Agricultural production services investment | | |
|---|---|---|---|
| | OLS | 2SLS | IV--Tobit |
| Quality of nonfarm employment | 0.005** | 0.198*** | 0.299*** |
| | -0.002 | -0.066 | -0.105 |
| Age | -0.003 | -0.033*** | -0.047** |
| | -0.004 | -0.012 | -0.02 |
| Education | 0.073*** | 0.088*** | 0.153*** |
| | -0.01 | -0.017 | -0.028 |
| Health | -0.01 | 0.012 | -0.004 |
| | -0.034 | -0.053 | -0.086 |
| Percentage of women | -0.319 | -0.421 | -0.804 |
| | -0.22 | -0.329 | -0.559 |
| Household size | 0.009 | -0.017 | -0.031 |
| | -0.023 | -0.035 | -0.059 |
| Household dependency ratio | -0.016 | -0.094 | -0.13 |
| | -0.083 | -0.123 | -0.214 |
| Arable land area | 0 | -0.004* | -0.008* |
| | -0.001 | -0.002 | -0.004 |
| Land Assets | 0.373*** | 0.159* | 0.261* |
| | -0.03 | -0.096 | -0.157 |
| Financial Assets | 0.013 | 0.024 | 0.038 |
| | -0.017 | -0.026 | -0.043 |
| Financial liabilities | 0.024*** | 0.027* | 0.044* |
| | -0.009 | -0.014 | -0.023 |
| Plain | 2.161*** | 2.671*** | 4.458*** |
| | -0.102 | -0.22 | -0.359 |
| Hilly | 0.096 | 0.226 | 0.472* |

| | | | |
|---|---|---|---|
| | -0.102 | -0.165 | -0.273 |
| Village Economy | 0.053 | 0.045 | 0.092 |
| | -0.033 | -0.052 | -0.083 |
| Constant | -1.877*** | -6.174*** | -13.212*** |
| | -0.437 | -1.484 | -2.413 |
| Observations | 5502 | 5263 | 5263 |

Note: *, **, and *** represent significant at the 10%, 5%, and 1% statistical levels, respectively; robust standard errors are in parentheses.

Table 5 indicates that an increase in the quality of nonfarm employment has a significant and favorable impact on the usage of agricultural production services, and these results are robust when tested using the instrumental variables approach. This demonstrates that the increase in the quality of farmers' nonfarm employment and the reduction in the agricultural labor force result in the substitution of agricultural labor factors by increasing flexible investments and purchasing agricultural production services.

### 4.3. Discussion

These results suggest that the quality of nonfarm employment improvement can effectively increase the flexible agricultural investments in farm households. The intrinsic reason is that the increase in nonfarm employment income increases farm households' capital accumulation, allowing them to have enough investment in agricultural production. In contrast, investment plays a substitution role for labor, resulting in higher investment in flexible agricultural assets. The results also demonstrate that the increased quality of nonfarm employment significantly and positively affects farm households' use of agricultural production services. The reduction in agricultural labor due to farmers' nonfarm employment is compensated by increasing investment in flexible agricultural assets and purchasing agricultural production services.

There is no substantial relationship between the quality of nonfarm employment and farm households' investment in fixed assets. On the one hand, although farmers' nonfarm employment uses household labor for agricultural production, it is possible that the effective household agricultural labor does not decrease or that the quality of nonfarm employment increases the use of agricultural production services so that it has no impact on farmers' purchases of agricultural machinery. However, because agricultural machinery is a dedicated agricultural asset, the seasonal nature of agricultural production determines the low frequency of use of dedicated assets, leading to investment lock-in and sunk costs, and when the farming

scale of farmers is small, the machinery assets cannot be utilized optimally. So, even if the quality of farm households' nonfarm employment increases, farmers are unwilling to invest.

## 5. Conclusions

The government has always played a significant role in agricultural production investment. In addition to government public agricultural investment, encouraging farmers to invest in agricultural production is the key to agricultural development and agricultural production efficiency improvement in order to stimulate sustainable agricultural growth. Nonfarm employment as a significant source of income for farmers' investment in agricultural production cannot be overlooked, as demonstrated by relevant studies. However, studies have focused on the impact of farmers' nonfarm employment behaviors and nonfarm employment levels on agricultural production investment. Each of these studies only considers a single nonfarm employment factor and gives less consideration to the impact of comprehensive nonfarm employment quality factors on agricultural production investment. This article focuses on the impact of farmers' nonfarm employment quality on their investment in agricultural production, which is comprised of four dimensions: wages, working hours, social security, and employment stability.

Using 2012 CFPSS data, we evaluate the relationship between the quality of farmers' nonfarm employment and agricultural production investment. The results indicate that improving the quality of farmers' nonfarm employment can boost their investments in flexible assets for agricultural production. This investment is utilized mostly for agricultural production services in farmers' households and can replace agricultural labor lost to nonfarm employment. In this approach, farmers' households can simultaneously engage in agricultural production and nonfarm employment, maximizing their benefits. There is no substantial relationship between the quality of farmers' nonfarm employment and investment in agricultural fixed assets. This is because the improvement in the quality of farmers' nonfarm employment encourages agricultural production services in farmers' houses, thereby serving as a substitute for their equipment.

This study's findings provide valuable information on how to promote farm household investment in agriculture, which may be used as a guide for resolving the agricultural investment conundrum. Particularly in countries and regions like China, where farm households are employed in both the agricultural and non-agricultural sectors. Farmers' households seeking agricultural production services to make up for the labor shortage in

agricultural production and maintain sufficient labor in non-agricultural industries can also promote investment in agricultural production for the development of agricultural production that is sustainable.

Due to restrictions in data collection, the data used in this study is 2012 cross-sectional data. As a result, this study has limitations. It is possible to collect updated data and panel data for use in future research, which may yield more in-depth results.

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