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Differences in the impact of land transfer on poverty vulnerability among households with different livelihood structures

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Introduction: Eradicating poverty is the primary objective of the United Nations 2030 Agenda for Sustainable Development. While China has achieved great success in achieving poverty reduction targets, reducing the poverty vulnerability of rural households is crucial for ensuring the sustainability of poverty reduction gains. The purpose of land transfer is to ensure the continuous increase of farmers' income through efficient land use; it has become an important initiative for poverty alleviation in rural areas. Existing studies have confirmed the positive effect of land transfer on poverty alleviation, but few have explored the difference in the impact of land transfer on poverty vulnerability of households with different income structures.

Methods: Using data from the China Family Panel Survey (CFPS) from 2010 to 2020, this paper empirically examines the impact of land transfer on poverty vulnerability.

Results and discussion: The results show that land transfer has a significant positive impact on poverty vulnerability alleviation among rural households. Further comparing households with different livelihood structures, we find that land transfer is more effective in reducing poverty for non-farm employment-oriented household. Therefore, we suggest that the government should improve the land transfer system, increase agricultural subsidies, and consider the occupational differentiation among farmers to improve the poverty reduction effect of land transfer. These suggestions also provide a reference for promoting sustainable agricultural development and consolidating the achievements of poverty alleviation.

KEYWORDS

land transfer, poverty vulnerability, livelihood structures, sustainable development, rural households

1 Introduction

Poverty eradication is a major challenge facing all countries in the world. In the past few decades, the Chinese government's comprehensive victory in poverty alleviation has provided valuable experience for the global poverty reduction cause (Guo et al., 2022). However, this achievement hides challenges and risks: the threat of falling back into poverty constantly tests the goal of sustainable development. Faced with multiple factors such as economic restructuring, income inequality, natural disasters and social change, marginalized groups still

face the possibility of falling back into poverty in the future (McElwee et al., 2023; Yang et al., 2023). At the same time, the marginal groups have insufficient self-development ability and poor resistance to external risks, which intensifies the risk of returning to poverty (Lu X. J. et al., 2023). Therefore, China still has a long way to go in pursuing the goal of sustainable poverty reduction.

As a spatial carrier of various resource elements, land plays a crucial role in ecological improvement, economic development and social progress (Tan et al., 2020; Zhou et al., 2020a; Jiao and Xu, 2021). While land remains the most important production resource in rural areas, China's rapid urbanization has resulted in a significant influx of rural populations into cities, leading to a decreased reliance on land resources by farmers (Dang et al., 2020; Zheng et al., 2022). Problems such as idle rural land and inefficient utilization of agricultural land are important constraints on current rural economic development (Li et al., 2020). The irrational utilization of land seriously hinders the improvement of agricultural productivity and the growth of farmers' income, making it detrimental to rural poverty reduction. With the continuous improvement of China's rural land system, land transfer plays a crucial role in poverty management and is regarded as an effective means to alleviate chronic poverty (Li et al., 2021; Chen et al., 2023). In addition, the change in occupational structure triggered by land transfer enables farmers to access more resources and opportunities for upward mobility in social class (Yang et al., 2021). The diversification of livelihoods among farm households can significantly raise the income levels, thus alleviating their poverty situations (Paudel Khatiwada et al., 2017). Therefore, proper land utilization is crucial for poverty management and sustainable livelihoods of rural households.

There is growing evidence that land transfer raise income levels and reduce household poverty. Based on the types of household livelihood strategies, existing studies can be categorized into three groups. The first category analyzes the poverty reduction effects of land transfer from the perspective of agricultural production activities. Research has shown that land transfer can not only optimize the allocation of land resources, but also indirectly improve agricultural production efficiency by raising the level of mechanization (Chari et al., 2021; Foster and Rosenzweig, 2022). Farmers promote the increase of agricultural business income through large-scale production, thus effectively alleviating the incidence of poverty. However, some scholars argue that land reforms have not led to improvements in agricultural productivity, thereby hindering the increase in agricultural income (Adamopoulos and Restuccia, 2020). The second category explores the impact of land transfer on income structure and poverty alleviation from the perspective of non-farm employment activities. The study found that land transfer liberates the family's labor force, prompting family members to transfer to secondary and tertiary industries and realize non-farm employment (Zheng et al., 2019; Zhou et al., 2020b). Moreover, non-farm employment can significantly increase wage income and effectively reduce the likelihood of the family falling into poverty in the future (Imai et al., 2015). The third category examines the poverty reduction effects of land transfer from the perspective of non-farm business activities. The study notes that more able workers may be inclined to engage in non-farm operations to boost household income (Melesse and Bulte, 2015). In addition, some scholars have shown that land transfer has not increased the income level of households. Their findings indicate that while participation in land leasing generates rental income, the household's non-farm income has not increased, resulting in insignificant changes in total income (Zhang L. et al., 2018). As a result, the risk of households falling into poverty was not reduced.

Land transfer has been shown to have a significant impact on household income and poverty, but there are still some limitations in the study. First, most studies have proved the poverty reduction effect of land transfer, but the measurement of poverty is mostly based on a static perspective, which cannot show the future trend of poverty. Second, the existing literature primarily classifies livelihood strategies based on the income structure of households (Liu et al., 2020; Xie et al., 2023). However, for rural households, incomes are unstable and susceptible to the external environment, making it difficult to accurately reflect a household's investment in a particular livelihood activity. Third, previous studies mainly focused on the average impact of land transfer on poverty, and rarely considered the heterogeneous impact of land transfer on poverty among households with different livelihood structures. Finally, existing studies mainly rely on cross-sectional data, which makes it challenging to identify the dynamic impact of land transfer on poverty.

In order to fill the gaps in existing research, this paper empirically analyzes the impact of land transfer on poverty vulnerability of households with different income structures by using the data of China Family Panel Studies (CFPS) from 2010 to 2020. The marginal contribution of this paper includes three main aspects. First, we use the poverty vulnerability index to measure the possibility of households falling into poverty in the future after the risk shock, so as to better investigate the long-term poverty reduction effect of land transfer. Second, this paper adopts a method combining multiple indicators and K-mean clustering to classify households' livelihood strategies, overcoming the limitations of using a single income structure as a classification criterion. Third, the paper explores the heterogeneous impact of land transfer on the poverty vulnerability of households with different livelihood structures. This study provides valuable insights for optimizing land resource allocation, improving the poverty governance system, and promoting sustainable rural development.

The remainder of this paper is organized as follows. Section 2 is theoretical analysis and research hypothesis. Section 3 describes the data source, variables, and methods used. Section 4 analyzes the empirical results. Section 5 discusses the results. Section 6 summarizes the main conclusions and provides relevant policy implications.

2 Theoretical analysis and research hypothesis

2.1 Impact of land transfer on poverty alleviation

Uncertainty of income sources, lack of livelihood assets, and a single livelihood approach all increase the risk of poverty for farm households (Wang et al., 2021). Rational allocation of land resources is gradually becoming a rational choice for farmers to diversify their incomes and resist the risk of poverty. Therefore, rural poverty management should not only rely on the support of poverty alleviation policies, but also make reasonable livelihood choices based on the resources possessed by families. Land consolidation is one way to promote poverty alleviation (Zhou et al., 2019). It also has a significant impact on food production, ecological environment, sustainable

livelihoods and regionally coordinated development (Liu and Li, 2017; Zhou et al., 2019; Xia et al., 2020).

More and more scholars began to study the relationship between land transfer and rural poverty management. On the one hand, land transfer can optimize the allocation of cultivated land resources and achieve scale management (Zhang L. et al., 2018; Zhang X. B. et al., 2018); On the other hand, it can also improve agricultural production efficiency and drive the transformation of agricultural industry to promote high-quality agricultural development (Chari et al., 2021), thus benefiting rural residents. Moreover, land transfer can also reduce the incidence of poverty among households by increasing non-farm employment opportunities. They found that land transfer reduces agricultural costs and pushes labor into more economically rewarding off-farm work (Zhou et al., 2020b), thereby improving the overall welfare of farmers. In addition, while affecting the allocation of labor resources, land transfers can also influence households' agricultural technology choices (Zhou et al., 2020c), which further alleviates poverty. From the perspective of poverty vulnerability, scholars also found that land transfer can alleviate the poverty vulnerability of households (Chen et al., 2023; Lu X. J. et al., 2023; Lu H. Y. et al., 2023). The collaboration model between the government and social capital has a more significant effect on alleviating poverty vulnerability (Zhang et al., 2022). Further analysis finds that non-farm employment helps households escape poverty by circumventing the income instability associated with agricultural production (Imai et al., 2015). Therefore, land transfer can promote the increase of family income through non-farm employment and large-scale operation, thus playing a role in preventing families from returning to poverty. We propose Hypothesis 1 (Figure 1):

> *Hypothesis 1:* Land transfer positively affects the poverty vulnerability of households from multiple dimensions.

2.2 Heterogeneous impacts on household livelihood structures

Since land is an important livelihood capital for rural households, the revitalization of land resources plays an important role in the development of sustainable livelihoods for poor households. This is because it provides households with diversified livelihood strategies and improves their resilience to the risks of uncertainty (Wang Y. et al., 2019). Generally speaking, households with low-income levels and a homogenous income structure are more vulnerable to poverty (Wang et al., 2021). While income growth can alleviate poverty, widening income inequality inhibits poverty reduction to some extent (Baloch et al., 2020). Specifically, low-income groups face a weaker foundation for development and are at a higher risk of falling into poverty. Hence, equalizing and diversifying the structure of household income as soon as possible can more effectively leverage the role of various income types in poverty alleviation.

A family's livelihood strategy is closely related to its income level (Pagnani et al., 2020). Typically, households' livelihood strategies are classified into purely agricultural, diversified, and non-agricultural categories based on their primary source of income (Yang et al., 2021). These households have different characteristics and different income structures in their daily production and life. Changes in household income structure play an important role in poverty alleviation. For the families mainly in agricultural production, land transfer provides them with the opportunity to obtain sufficient cultivated land resources, meeting the requirements of their large-scale management (Zhang L. et al., 2018; Zhang X. B. et al., 2018). However, backward agricultural production technology and low production efficiency lead to improper allocation of land resources (Adamopoulos et al., 2022). As a result, income growth from agricultural production was unable to compensate for the decline in non-farm income, resulting in

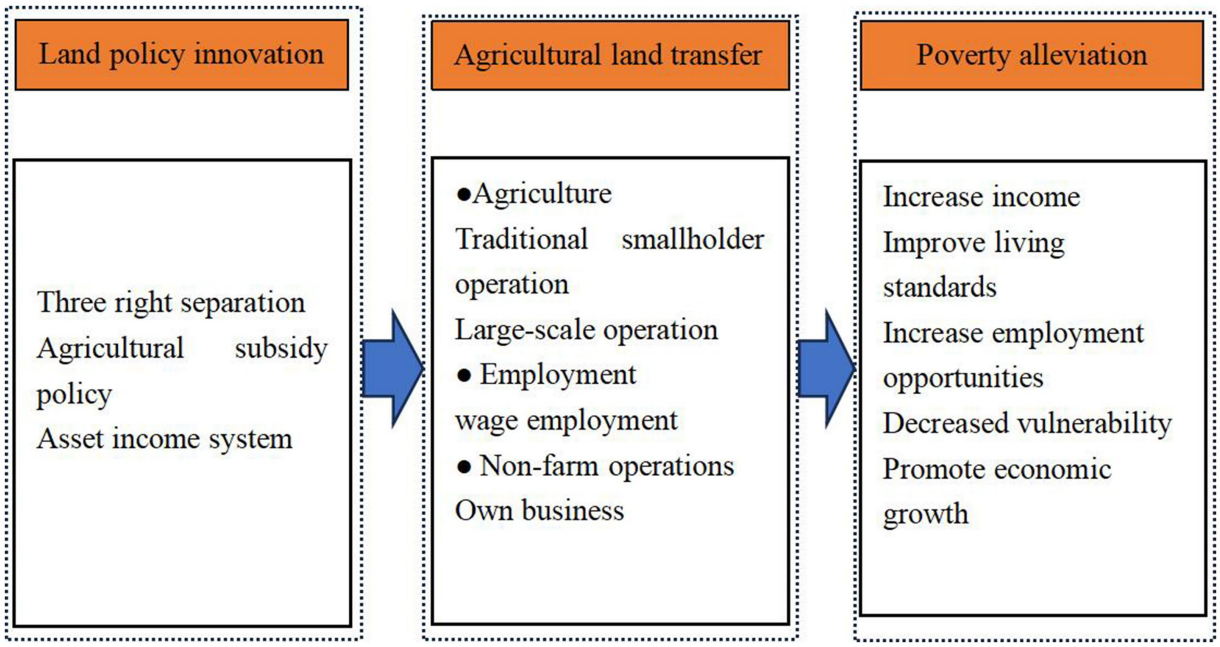

FIGURE 1
A theoretical framework for land transfer and poverty alleviation.

negligible household income growth. For households dominated by non-farm business, while land transfers can generate rents and enhance the property income of households (Peng et al., 2020), this income constitutes a small percentage of the household income structure. Consequently, it makes a limited contribution to the total income, exerting little impact on poverty alleviation. For employment-oriented households, non-farm employment can expand income sources and help rural households achieve long-term poverty alleviation (Imai et al., 2015). And from the perspective of family income structure, wage income, especially part-time income, is the largest contribution to family income. Land transfer can increase non-agricultural employment opportunities and raise wage income levels. In addition, with changes in household livelihood strategies, an increase in wage income can reduce the vulnerability to poverty resulting from loss of agricultural income (Zereyesus et al., 2017). We propose Hypothesis 2:

> *Hypothesis 2:* The poverty alleviation effect of land transfer is more significant for non-farm employment-oriented households because it has a stronger effect on wage income.

3 Materials and methods

3.1 Data source

The data used in this paper come from the China Family Panel Survey (CFPS) conducted by the China Social Science Research Center of Peking University. The data, which started in 2010 and is surveyed every 2 years, covers 162 counties in 25 provinces, making it nationally representative. The program annually surveys 16,000 target households, including all members of the household. The database systematically reflects China's economic and social development and changes at the micro level by tracking data at the individual, household and community levels.

The CFPS data utilizes implicitly stratified, multi-stage, multi-level, probability sampling proportional to population size, as well as computer-assisted face-to-face interviewing (CAPI) and computer-assisted televisual interviewing (CATI) techniques, which ensures the quality of the data to a certain extent.

Prior to the empirical analysis, this paper processed the data as follows: first, focusing exclusively on rural areas, the urban sample was excluded; second, because the CFPS data do not provide clear information about the head of household, this paper considers the household financial respondent as the head of household and deletes the sample under the age of 16. Third, we match the personal database with the family database to screen out the personal characteristic variables and calculate the family variables. Finally, we merge the 2010–2020 data, removing missing variables and unrecognizable observations, resulting in a total of 31,382 samples.

3.2 Variable selection

3.2.1 Dependent variable

Poverty vulnerability is the link between risk shocks and household welfare levels, which is unobservable and dynamic (Bouzarovski, 2014; Sinha et al., 2022). Poverty vulnerability is an advance prediction of poverty, which describes the likelihood that a household or individual will fall into poverty in the future (Gillard et al., 2017; Khosla and Jena, 2023). As poverty vulnerability is a forward-looking concept, it cannot be directly observed at current or past points in time and requires measurement through specific methods. The VEP method not only considers the heterogeneity associated with individuals (families), but also takes into account the dynamic and prospective characteristics of the risk of returning to poverty. It has been widely utilized by scholars both domestically and internationally (Wang and Fu, 2021). Therefore, this paper utilizes the Vulnerability as Expected Poverty (VEP) method proposed by Chaudhuri et al. (2002) to measure the poverty vulnerability of rural households. The value of poverty vulnerability ranges from 0 to 1, with a larger value indicating a higher probability of a household falling into poverty.

3.2.2 Independent variable

On the one hand, the decentralized management of small farmers can no longer meet the needs of farmers for sustainable income growth (Hao et al., 2023); On the other hand, the actual needs of agricultural development urgently need to realize agricultural scale management through agricultural land transfer, and solve the key problems of agricultural modernization and high-quality development (Fei et al., 2021). Drawing on existing research, this paper measures land transfers by whether households have land transfers out or land transfers in. If the answer is "yes," we consider that the household is involved in land transfer and assign a value of 1; otherwise, the value is 0.

3.2.3 Control variables

The effect of poverty reduction may also be influenced by factors such as individual and household characteristics (Zhang et al., 2020; Cheng et al., 2021). Based on the existing literature, we added household head characteristics and family characteristics as control variables in our model. Specifically, the personal characteristics of the head of the household include age, gender, marital status, and education level. Household characteristics include household size, homeownership, the value of fixed assets, borrowing opportunity from both others and financial institutions, and the receipt of government subsidies. Additionally, we include household and time fixed effects in our model to eliminate the impact of unobservable individual heterogeneity and external factors, such as the macroeconomic environment, on household vulnerability to poverty. Table 1 provides definitions and descriptive statistics of the variables used in this study.

3.3 Method

3.3.1 Measurement of poverty vulnerability

The VEP method generally uses the three-stage feasible generalized least squares (FGLS) method to estimate the probability that a household will fall into poverty in the future. The specific calculation steps are as follows:

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TABLE 1 Variable definitions and descriptive statistics.

Variables	Description	Mean	Standard deviation	Maximum	Minimum
Dependent variable					
Poverty vulnerability	Likelihood that the household will fall into poverty in the future	0.0909	0.1415	0	1
Independent variable					
Land transfer	Whether the household is involved in land transfer out or land transfer in	0.2508	0.4335	0	1
Control variables for household head characteristics					
Age	Age of household head	51.1584	13.0838	16	94
Gender	Male = 1, female = 0	0.6156	0.4865	0	1
Educational level	Illiterate = 1, primary school = 2, junior middle school = 3, senior high school = 4, college and above = 5	2.1803	1.0524	1	5
Marital status	Married = 1; unmarried = 0	0.8832	0.3211	0	1
Control variables for household characteristics					
Household size	The number of household members	4.0787	1.9154	1	16
House	Assign a value of 1 if the family owns a house and otherwise 0	0.9382	0.2407	0	1
Fixed assets	The natural Logarithm of the value of fixed assets owned by households	4.1348	4.3118	0	17.7275
Borrowed money	Assign a value of 1 if the household borrows money from others and 0 otherwise	0.0905	0.2869	0	1
Loan	Assign a value of 1 if the household borrows money from financial institutions and 0 otherwise	0.1878	0.3907	0	1
Government subsidies	Assign a value of 1 if the household receives government subsidies and 0 otherwise.	0.4490	0.4974	0	1

Step 1: Estimate the income equation:

$$\ln Y_i = \alpha X_i + e_i$$

Where Y_i represents annual *per capita* household income. According to relevant literature, the control variable X_i in this paper mainly includes: characteristics of the household head, such as age, gender, marital status and education level; And household characteristics, such as household size, housing, fixed asset, etc.

Step 2: Estimate the expected value and variance of logarithmic income to get:

$$\hat{\mu} = \hat{E}\left[\ln Y_i \mid X_i\right] = X_i \hat{\alpha}$$

$$\hat{\sigma_i^2} = \hat{Var}\left[\ln Y_i \mid X_i\right] = X_i \hat{\beta}$$

Step 3: Drawing on Chaudhuri et al. (2002), vulnerability can be obtained by assuming that future household income follows a lognormal distribution:

$$\hat{VUL_i} = \hat{\Pr}\left(\ln Y_i \le lnPoor\right) = \Phi\left[\frac{lnPoor - X_i \hat{\alpha}}{\sqrt{X_i \hat{\beta}}}\right]$$

3.3.2 Econometric model

In order to test the effect of land transfer on the poverty vulnerability of households, this paper constructs the following regression model:

$$Y_{it} = \alpha_0 + \alpha_1 LT_{it} + \alpha_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where Y_{it} denotes the poverty vulnerability of the i family in year t, LT_{it} denotes the land transfer status of the i household in year t; X_{it} is a control variable that includes the head of household and family characteristics, such as age, gender, education level, family size. $\propto_i$ denotes household fixed effects to control for unobservable factors that do not change over time at the household level. λ_t denotes year fixed effects to control for influences that vary over time but not with households, such as the macroeconomic environment. ε_{it} denotes the random error term.

4 Results

4.1 Baseline results

The regression results of land transfer on poverty vulnerability are presented in Table 2. In Column (1), a regression model without control variables is shown. In Column (2), the personal characteristic variable of the household head is added, and in Column (3), control variables at the individual and household levels are included. The results reveal that the regression coefficients of land transfer are all

TABLE 2 Results of baseline regression.

	Dependent variable: poverty vulnerability		
	(1)	(2)	(3)
Land transfer	−0.0083***	−0.0081***	−0.0074***
	(0.0019)	(0.0018)	(0.0017)
Age		0.0015***	0.0017***
		(0.0001)	(0.0001)
Gender		0.0177***	0.0212***
		(0.0018)	(0.0017)
Marriage		−0.0326***	−0.0422***
		(0.0037)	(0.0035)
Educational level		−0.0449***	−0.0444***
		(0.0012)	(0.0012)
Fixed assets			−0.0034***
			(0.0002)
Family size			0.0174***
			(0.0008)
House			0.0042
			(0.0031)
Borrowed money			−0.0200***
			(0.0022)
Loan			0.0433***
			(0.0018)
Government subsidies			−0.0555***
			(0.0019)
Constants	0.0930***	0.133***	0.0869***
	(0.000758)	(0.00736)	(0.0081)
Household FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
R-squared	0.5746	0.6127	0.6552
Observations	31,382	31,382	31,382

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

negative in the three models and have all passed the significance test at the 1% level. This indicates that land transfer is effective in mitigating the poverty vulnerability of households, thus verifying Hypothesis 1.

4.2 Robustness checks

4.2.1 Replacement of poverty criteria

In China, a family is deemed poor if its net income falls below the country's current rural poverty line. However, many developing countries widely recognize the international poverty standards set by the World Bank at $1.9 per person per day and $3.2 per person per day (Islam et al., 2021). To ensure robustness, this paper conducts testing based on the World Bank's poverty criteria. In additional, following the practice of European Union countries, relative poverty lines are also considered for robustness testing, using 50 and 60% of the median *per capita* household income (Özsoy and Gürler, 2022).

The regression results are shown in Table 3. It can be found that the regression coefficients in columns (1) and (2) are significantly negative under the absolute poverty criterion. Under the relative poverty criterion, the regression coefficients of columns (3) and (4) are still significantly negative. This suggests that land transfer can significantly reduce the poverty vulnerability of households. Therefore, regardless of which poverty criterion is used, the results obtained are not significantly different, indicating that the results are robust.

4.2.2 Change the measurement of the explained variable

Based on the poverty vulnerability line, we can determine whether a household is poverty-vulnerable. Therefore, this paper introduces a poverty vulnerability dummy variable as an explanatory variable to further test the robustness of the baseline regression results. Referring to existing research, this paper uses 0.5 as the poverty vulnerability line (Ward, 2016). If the household's poverty vulnerability value is higher than 0.5, it is assigned a value of 1; otherwise, it is assigned a value of 0.

The results are shown in column (5) of Table 3. As expected, even when we substitute poverty vulnerability with a dummy variable, land transfer is still significantly negatively association with poverty vulnerability. Hence, the estimation results remain robust.

4.2.3 Transform the regression samples

Considering that the heads of households in the sample are older, they have a higher likelihood of falling into poverty, which may lead to errors in the regression results. Therefore, we exclude samples where the heads of households are older than 65 years and conduct further robustness tests.

Column (6) of Table 3 presents the regression results. It can be found that the size and sign of the estimated coefficients for land transfers do not change significantly and pass the significance test at the 1% level, once again confirming the robustness of the results.

4.3 Endogenous test

There may be reverse causality between land transfer and poverty vulnerability; in other words, while land transfer affects poverty vulnerability, households' poverty vulnerability may also influence their willingness to participate in land transfer. For example, economic constraints and limited production capacity pose challenges for impoverished families aiming to engage in large-scale operations through land transfer. Furthermore, the generally low level of professional skills among farmers hinders their advantage in non-farm employment, thereby impacting household land transfer behaviors. Therefore, in order to alleviate the endogenous problem caused by reverse causation, this paper chooses instrumental variable method for regression. Drawing on Démurger and Xu, this paper regards the proportion of other households participating in land transfer in the same village, excluding interviewees' families, as an instrumental variable (Démurger and Xu, 2011). On the one hand, the participation of other families in land transfer can reflect the active degree of land transfer in the area. At the same time, due to the characteristics of rural clan network and human society, the level of land transfer in the

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TABLE 3 Results of the robustness test.

	(1)	(2)	(3)	(4)	(5)	(6)
	Replacement of poverty criteria				Change the measurement of the explained variable	Transform the regression samples
	Absolute poverty standard		Relative poverty standard			
	$1.90 / day	$3.2/day	Median 50%	Median 60%	Poverty vulnerability	Poverty vulnerability
Land transfer	−0.0103***	−0.0094***	−0.0091***	−0.0102***	−0.0060**	−0.0074***
	(0.0023)	(0.0023)	(0.0021)	(0.0022)	(0.0025)	(0.0017)
Age	0.0025***	0.0022***	0.0025***	0.0026***	0.0012***	0.0014***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Gender	0.0435***	0.0715***	0.0420***	0.0535***	0.0131***	0.0211***
	(0.0024)	(0.0025)	(0.0023)	(0.0024)	(0.0027)	(0.0018)
Marriage	−0.0591***	−0.0475***	−0.0614***	−0.0615***	−0.0214***	−0.0302***
	(0.0048)	(0.0046)	(0.0046)	(0.0047)	(0.0057)	(0.0040)
Educational level	−0.0955***	−0.147***	−0.0875***	−0.111***	−0.0207***	−0.0423***
	(0.0017)	(0.0017)	(0.0016)	(0.0017)	(0.0017)	(0.0012)
Fixed assets	−0.0060***	−0.0067***	−0.0053***	−0.0060***	−0.0014***	−0.0030***
	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Family size	0.0329***	0.0443***	0.0313***	0.0379***	0.0159***	0.0166***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0014)	(0.0009)
House	0.0181***	0.0412***	0.0155***	0.0235***	0.0123***	0.0053*
	(0.0042)	(0.0043)	(0.0042)	(0.0044)	(0.0040)	(0.0031)
Borrowed money	−0.0448***	−0.0701***	−0.0327***	−0.0431***	−0.0186***	−0.0178***
	(0.0031)	(0.0034)	(0.0030)	(0.0032)	(0.0028)	(0.0021)
Loan	0.0864***	0.104***	0.0734***	0.0878***	0.0274***	0.0416***
	(0.0024)	(0.0024)	(0.0022)	(0.0023)	(0.0033)	(0.0019)
Government subsidies	−0.0853***	−0.0988***	−0.0896***	−0.0986***	−0.0394***	−0.0489***
	(0.0024)	(0.0023)	(0.0023)	(0.0023)	(0.0032)	(0.0020)
Constants	0.238***	0.557***	0.200***	0.286***	−0.0308**	0.0791***
	(0.0108)	(0.0111)	(0.0107)	(0.0110)	(0.0133)	(0.00852)
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7634	0.8224	0.7403	0.7873	0.3365	0.6593
Observations	31,382	31,382	31,382	31,382	31,382	26,236

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

region has a great correlation with the family's land transfer intention. On the other hand, the land transfer of other families in the village does not affect the family's poverty vulnerability, which satisfies the principle of externality.

Table 4 presents the estimation results using instrumental variables. The results indicate that the estimated coefficient of the instrumental variables in the first stage is 0.5230, significant at the 1% level, confirming that the correlation requirement of the instrumental variables is satisfied. In additional, the Kleibergen-Paap rk Wald F statistic is 510.92, indicating that there is no under-identification of instrumental variables; The Cragg-Donald Wald F statistic is 854.13, which is greater than the critical value of 16.38 at the 10% level of the Stock-Yogo weak instrumental variable test, indicating that there is no weak instrumental variable. In the second stage, the estimated coefficient of land transfer is −0.0655, significant at the 1% level. This indicates that land transfer still has a significant negative impact on poverty vulnerability even after addressing the endogenous problem. Thus, Hypothesis 1 is further validated.

TABLE 4 Regression results of instrumental variable.

Variables	(1)	(2)
	2SLS first Stage	2SLS second Stage
	Land transfer	Poverty vulnerability
Land transfer		−0.0655***
		(0.0109)
Proportion of land transfer	0.5230***	
	(0.0231)	
Control variables	Yes	Yes
Household FE	Yes	Yes
Time FE	Yes	Yes
Observations	31,382	31,382
Cragg-Donald Wald F statistic	854.13	
Kleibergen-Paap rk Wald F statistic	510.92	
Centered R2	0.1501	

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

4.4 Further analysis

4.4.1 Classification of household livelihood structure

To test the differences in the impact of land transfer on the poverty vulnerability of households with different income structures, this paper comprehensively considers the income composition of households and the occupational distribution of family members (Wang P. et al., 2019; Wang Y. et al., 2019). Meanwhile, we consider the 31,382 rural households from 2010 to 2020 as a whole and use K-means cluster analysis to classify the livelihood structure of households in the sample. In terms of income composition, we use the proportion of agricultural income, wage income, non-agricultural business income, property income and transfer income in the total household income as input index for cluster analysis. In terms of the occupational distribution of members, we choose the proportion of the number of family members participating in agricultural activities, non-agricultural employment activities and non-agricultural business activities in the total number of family members as input index for cluster analysis.

In this paper, the K-means cluster analysis is set to 3 categories, and the indicator characteristics of households in each category are shown in Table 5. By comparing the mean of the indicators in Table 5, we find that in the first category, agricultural income and the number of people engaged in agriculture constitute the largest proportion, accounting for 70.37 and 57.52%, respectively. Therefore, we define this category as "agriculture-oriented" households. In the second category, wage income and the number of workers constitute the largest proportion, accounting for 80.76 and 29.67%, respectively. Therefore, we define this category as "non-agricultural employment-oriented" households. In the third category, the non-farm business income and the number of non-farm business people represent the largest proportion, accounting for 8.83 and 6.80%, respectively. Therefore, we define this category as "non-farm business-oriented" households.

4.4.2 Heterogeneity analysis

Based on the livelihood structure of households, we examined the differences in the poverty reduction effects of land transfers. The results are presented in Table 6. It is evident that land transfer significantly alleviates the poverty vulnerability of farmers in the whole sample. However, the impact of land transfer on the poverty vulnerability of households with different livelihood structures varies. Specifically, the regression coefficients for non-farm employment-oriented households are negative and pass the significance test at the 1% level. Compared with households that do not participate in land transfer, it reduces the probability of non-farm employment-dominated households falling into poverty by 0.98%. For both agriculture-oriented and non-farm business-oriented households, the regression coefficient of land transfer is negative but not significant. Therefore, land transfer has a stronger poverty alleviation effect on non-agricultural employment-oriented households. Hypothesis 2 is verified.

4.4.3 Impact of land transfer on different types of household income

Income levels significantly influence households' vulnerability to poverty. Household income comprises wage income, business income, property income, and transfer income (Lu X. J. et al., 2023; Lu H. Y. et al., 2023). Business income is further categorized into agricultural business income and non-agricultural business income. Therefore, to further analyze the reasons for the heterogeneous effects of land transfer, we examined the relationship between land transfer and household income from the perspective of income structure. The results are shown in Table 7. Land transfer has a significant positive effect on property income, transfer income and non-farm business income. Additionally, the effect on wage income is positive, although significant at the 10% level. In contrast, the impact of land transfer on agricultural income is significantly negative, indicating that land transfer will reduce agricultural income. Overall, land transfer significantly improves the total income of households.

The impact of land transfer methods on household income also varies. From the perspective of land transfer-out, land transfer-out significantly enhances the household's wage income, property income and non-farm business income, while significantly reduces the household's agricultural income. Overall, land transfer-out significantly boosts the total income of households. From the perspective of land transfer-in, land transfer-in significantly raised the household's agricultural income and transfer income. However, it has a significant negative effect on the growth of wage income, property income and non-farm business income. Overall, land transfer-in significantly increases the total income of households.

5 Discussion

5.1 Evaluation of the impact of land transfer on poverty vulnerability

In this study, we employed poverty vulnerability indicators to evaluate the influence of land transfer on the alleviation of poverty in

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TABLE 5 The mean of each indicator in different types of households.

Indicators	Category 1	Category 2	Category 3	Total sample
	Agriculture-oriented	Non-farm employment-oriented	Non-farm business-oriented	
Proportion of agricultural income (%)	70.37	8.83	5.17	21.38
Proportion of non-farm business income (%)	0.65	0.84	8.83	2.58
Proportion of wage income (%)	11.92	80.76	7.44	49.41
Proportion of property income (%)	0.64	0.75	3.05	1.24
Proportion of transfer income (%)	6.55	3.60	38.06	11.94
Proportion of agricultural worker (%)	57.52	32.87	32.91	38.44
Proportion of non-farm employment (%)	7.60	29.67	4.83	19.32
Proportion of non-agricultural operators (%)	0.96	1.19	6.80	2.40
Observations	6,819	17,546	7,017	31,382

TABLE 6 Impact of land transfer on poverty vulnerability of households with different livelihood structures.

Variables	Total sample	Agriculture-oriented	Non-Farm employment-oriented	Non-farm business-oriented
Land transfer	−0.0074***	−0.0010	−0.0098***	−0.0063
	(0.0017)	(0.0041)	(0.0024)	(0.0051)
Control variables	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Constants	0.0869***	0.0960***	0.0773***	0.0959***
	(0.0081)	(0.0225)	(0.0110)	(0.0260)
R2	0.6552	0.7548	0.6874	0.6988

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE 7 Impact of land transfer on different types of household income.

Variables	Household income	Wage income	Property income	Transfer income	Agricultural income	Non-farm business income
Land transfer	0.1271***	0.1120*	2.1360***	0.0773**	−0.1732***	0.1005***
	(0.0156)	(0.0628)	(0.0389)	(0.0386)	(0.0636)	0.0316
Land transfer-out	0.1078***	0.2945***	4.4522***	−0.0067	−1.1835***	0.2978***
	(0.0215)	(0.0824)	(0.0746)	(0.0540)	(0.0870)	0.0442098
Land transfer-in	0.1270***	−0.0537	−0.1619***	0.108**	0.8004***	−0.0861***
	(0.0193)	(0.0843)	(0.0432)	(0.0478)	(0.0808)	0.0403
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes		Yes	Yes

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

rural households. Our first study shows that land transfer can significantly reduce rural households' vulnerability to poverty. This is consistent with the findings of Wang et al. (2022), who argue that land transfer has a stronger mitigating effect on the poverty vulnerability of relatively poor households. Globally, land transfers have achieved similar results. The World Bank's land reform report over the past two decades has found that land reform is a key poverty alleviation intervention (Varga, 2020). Farmers engaged in entrepreneurship and self-employment through land transfer, thereby alleviating poverty.

In addition, from the perspective of household income structure, we find that land transfer has a positive effect on increasing rural household income, especially transfer income and property income. In order to further improve the land contract system, the government

provides certain rewards and financial subsidies to families involved in land transfer, resulting in the increase of household transfer income. The effect of land transfer on wage income is not significant, which may be because China's new urbanization has resulted in a large number of people moving from rural to urban areas and from the agricultural sector to the non-agricultural sector. Consequently, households involved in land transfer are likely to be farmers engaged in non-agricultural production, leading to the insignificance of the impact of land transfer on labor release (Zhang L. et al., 2018; Zhang X. B. et al., 2018). In general, land transfer improves the income structure of households and makes a positive contribute to their total income.

This paper discusses land transfer as an important means of poverty alleviation in China, especially its effect on poverty reduction by optimizing land resource allocation and increasing household income. However, the complexity of returning to poverty goes beyond the impact of a single factor. Understanding the combination of income and other factors is crucial in preventing the risk of falling back into poverty. Rising household incomes not only increase households' economic capacity, but also provide them with a source of funds to invest in education, health and social life (Barrington-Leigh, 2024). Such integrated investments help to increase households' resilience to risk and also create more stable opportunities for disadvantaged groups to move up in the broader social and economic context, thereby creating a virtuous cycle of poverty reduction (Xie et al., 2023). Therefore, in future studies, it is necessary to further understand and quantify the interaction of different factors in the risk of returning to poverty in order to accurately formulate targeted policies and measures.

5.2 Evaluation of the impact of land transfer heterogeneity

According to sustainable livelihood theory, households with greater livelihood capital tend to have more options for livelihood strategies and more diverse sources of income (Pagnani et al., 2020). The results show that land transfer can reduce the poverty vulnerability of non-farm employment-oriented households. Large-scale population migration is a significant phenomenon in China's economic and social development. From the actual situation in rural areas, more and more farmers choose to participate in land transfer and work in the city to improve their family's economic income. Moreover, land transfer plays a significant role in alleviating households' poverty vulnerability. This is also confirmed by Chen et al. (2023). After the land is transferred out, households invest less labor and time in agricultural production, optimizing the allocation of labor resources within the household. Family members can engage not only in higher-paying non-farm work but also obtain a consistent and stable rental income, thereby enhancing the family's economic level. In addition, government incentives also contribute to increased household income. Thus, the diversification of income sources brought about by land transfer helps to reduce the risk of income fluctuations for rural households, thereby alleviating their vulnerability to poverty.

We found that land transfer had no significant impact on the poverty vulnerability of agriculture-oriented households. Compared with non-farm employment-oriented households, agriculture-oriented households derive their income mainly from agricultural production. As a result, agricultural income plays a very important role in the income structure of such households. Overall, land transfer significantly reduces households' farm income. This may be due to the fact that land is the basis of agricultural production for rural households, and its transfer inevitably results in lower income from agricultural activities, increasing the risk of households falling into poverty. Although land transfer-in can significantly increase a household's income from agricultural production, due to a lack of human, financial, and technological resources, the area that households choose to lease tends to be relatively small and unable to generate economies of scale (Ženka et al., 2016; Lu et al., 2019). Moreover, land in rural China is decentralized, and an increase in the number of leases contributes to a higher degree of fragmentation. This fragmentation significantly impacts the efficiency of agricultural production, as supported by Hao et al. (2023). They observed that fragmented arable land hampers the adoption of agricultural machinery, resulting in a notable decrease in agricultural productivity. As a result, the fragmented management of land restricts the increase of household agricultural income and is not conducive to poverty alleviation. In addition, with the exacerbation of China's aging population, a majority of individuals involved in agricultural production are older. Their agricultural production methods tend to be more traditional and resistant to embracing new knowledge and technology, leading to a sluggish growth in agricultural income. Thus, household participation in land transfer-in can increase income from agricultural production, but the rise is limited. Given the substantial decline in wage incomes, an increase in agricultural incomes is not sufficient to reduce the probability of households falling into poverty in the future.

It is worth considering that when we discuss poverty reduction strategies, land transfer is often seen as an effective tool. However, there are significant differences in the livelihood structure of different households, and these differences change over time. For example, in some regions, the advancement of agricultural modernization and marketization may require longer-term land-use planning and technical support, while in others, infrastructure development and technical training may be needed to promote off-farm employment (Liu et al., 2024). Sustainable poverty reduction therefore requires comprehensive strategies that address these dynamic changes in livelihoods and provide diverse and flexible support measures. In addition, a comprehensive strategy is not only about land transfer, but also needs to take into account other relevant factors, such as financial support, technical training, market access and environmental protection (Wang and Fu, 2021; Ge et al., 2023; Duan et al., 2024). The combination of these factors can better meet the long-term needs of households and contribute to sustainable poverty reduction.

However, it is important to note that there are some limitations to this study. First, this paper only discusses the impact of whether households participate in land transfer on poverty vulnerability. Due to data limitations, it does not further analyze the relationship between land transfer area and poverty alleviation. Second, the study focused on rural China and did not consider a global sample. Cross-country comparisons of the poverty reduction effects of land transfer need further exploration.

6 Conclusions and policy implications

Land is a valuable resource for farmers, especially the vulnerable groups, to survive. Land transfer has emerged as a significant approach to poverty alleviation in China. It can optimize the allocation of land resources and increase household income, thereby reducing poverty. Using CFPS data from 2010 to 2020, this paper analyzes the impact of land transfer on poverty vulnerability. Meanwhile, K-mean clustering was used to classify households' livelihood strategies, further exploring the heterogeneous impact of land transfer on the poverty vulnerability of households with different livelihood structures. The main findings are as follows: first, on the whole, land transfer has a significant positive impact on the alleviation of household poverty vulnerability. Second, from the perspective of livelihood structure, land transfer significantly alleviates the poverty vulnerability of non-farm employment-oriented households, while the effect on the poverty vulnerability of agriculture-oriented and non-farm business-oriented households is not significant. Third, in terms of income structure, land transfer has a significant positive impact on household property income, transfer income and non-farm business income, and a significant negative impact on agricultural production income. Based on the main findings, this paper proposes the following policy recommendations to better utilize the poverty reduction effects of land transfer.

1. For agriculture-oriented farmers, improving the effect of land transfer on poverty reduction should be started from improving land management technology, optimizing agricultural infrastructure and promoting brand building of agricultural products. Improving land productivity and the quality of agricultural products through the promotion of modern agricultural techniques; Strengthen the construction of farmland water conservancy facilities, reduce costs and improve competitiveness; Support the construction of farmers' cooperatives and the branding of agricultural products to raise the added value of agricultural products, so as to achieve long-term stable agricultural income.
2. For non-agricultural employment-oriented farmers, to improve the poverty reduction effect of land transfer, it is necessary to further strengthen vocational training and skill upgrading, improve labor market information services, and improve labor rights protection. Provide targeted vocational skills training and certification to enhance the employment competitiveness of migrant workers; improve the labor market information platform to provide timely and accurate employment information; strengthen the rights protection of migrant workers to ensure that they enjoy fair treatment and stable non-agricultural employment income.
3. For farmers dominated by non-agricultural operations, to improve the poverty reduction effect of land transfer, it is necessary to support entrepreneurship and financing, optimize the entrepreneurial environment, and expand the market and cooperation. Provide entrepreneurship training and consulting services to help farmers acquire entrepreneurial knowledge and skills; Simplify the approval process of entrepreneurship registration, and reduce the threshold and cost of entrepreneurship; Organize entrepreneurship exhibitions to help farmers explore markets and find partners, thereby promoting the development of off-farm business projects and stable earnings.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

XZ: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. FL: Funding acquisition, Supervision, Writing – review & editing. MG: Formal analysis, Validation, Writing – review & editing. LZ: Data curation, Writing – review & editing, Supervision.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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