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The impact of livelihood capital on the social integration of relocated households: mediating effects based on livelihood risk

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The social integration of relocated migrants directly determines the success or failure of poverty alleviation relocation efforts. This paper aims to explore the impact of livelihood capital on the social integration of relocated households and the underlying mechanisms. Based on the sustainable livelihoods framework, the Ordinary Least Squares (OLS) model, quantile regression model, and mediation analysis are used to investigate the relationships between livelihood capital, livelihood risk, and the social integration of relocated households, using 610 survey responses from relocated poverty alleviation households in China collected in 2024. The results are as follows: (1) Overall, livelihood capital has a significant positive effect on the social integration of relocated households. For every one-unit increase in livelihood capital, the social integration level of relocated households increases by 55.32%. However, as the level of social integration improves, the effect of livelihood capital on social integration gradually diminishes. (2) The livelihood risk of relocated households plays a partial mediating role in the process through which livelihood capital affects social integration. In terms of sub-dimensions, environmental risk, employment risk, and health risk each play a partial mediating role in this process. (3) Further analysis reveals that livelihood capital has a more significant positive effect on the social integration of relocated households in township resettlements, part-time agricultural livelihoods, and female-headed households compared to urban resettlements, non-agricultural households, and male-headed households. Based on these findings, the government should focus on improving the livelihood capital of relocated households in multiple dimensions, design and implement multi-layered risk management strategies, and adopt differentiated policies tailored to the specific circumstances and needs of each group to promote the social integration of relocated households.

KEYWORDS

social integration, livelihood capital, livelihood risk, relocation for poverty alleviation, mediating effect

1 Introduction

Relocation for poverty alleviation is the foremost project within the "Five Batches" initiative for precise poverty alleviation. By the end of 2020, the task of relocating over 9.6 million impoverished individuals were completed, making significant contributions to the battle against poverty and the achievement of the first centennial goal (Feng et al., 2024; Hu et al., 2022). However, "moving out" is only the first phase of the process. While relocation improves the living environment of the impoverished, it also has far-reaching effects on their production and lifestyle, ideological perspectives, and daily habits (Bai et al., 2022; Cao et al., 2024). After relocation, the farmers' original production system is disrupted, social networks

are dismantled, and psychological pressure increases due to the rapid changes in cultural customs, social norms, and living conditions (Feng et al., 2022; Wu et al., 2023). Ensuring that relocated households can better integrate into their new communities and lead normal lives have become a critical challenge in subsequent support efforts. From this perspective, the success of relocation programs hinges on the quality of social integration (Liu et al., 2023).

Livelihood capital refers to the various resources that farmers possess to mitigate external risks, maintain survival and development and improve their standard of living. This includes natural capital, material capital, human capital, social capital, and financial capital (Bouahom et al., 2004; Ma et al., 2024). Understanding how livelihood capital affects the social integration of relocated households is essential for assessing the effectiveness of poverty alleviation policies and improving follow-up support strategies, thereby enhancing the quality of life for relocated families (Zhao and Lan, 2023). Therefore, studying the social integration of relocated households from the perspective of livelihood capital is of both theoretical and practical significance. Previous research has shown that family endowment plays an important role in migrants' behavioral decisions, and their integration into urban areas is often influenced by a combination of factors, including livelihood capital (Lin et al., 2017). Upon entering the city, the capital status of the family serves as the foundation for migrants to transition from rural farmers to urban residents, and this process of identity transformation is accompanied by adjustments in livelihood capital. If this transformation fails, migrants may fall back into poverty and be forced to return to rural areas (Tian et al., 2019; Wang et al., 2023). The accumulation of natural and material capital increases the likelihood of migrants staying in rural areas, reducing their opportunities for contact with the outside world; conversely, a lack of natural and material capital accelerates their migration to urban areas (Mganga et al., 2015; Ranganathan and Pandey, 2018). Some scholars argue that natural and physical capital do not significantly influence social integration, while human, social, and financial capital have a substantial positive impact on integration (Li et al., 2022; Xie et al., 2022; Zhang et al., 2023). Therefore, migration to urban areas is not driven by a single type of capital but is a result of the combined effects of various forms of capital (Sam and Berry, 2010; Wu et al., 2024). Most existing studies focus on the impact of individual dimensions of livelihood capital on social integration, with little systematic consideration of the role of overall livelihood capital and its components. Furthermore, studies often adopt the sustainable livelihood framework developed by the UK Department for International Development (DFID), which overlooks the influence of psychological capital. Additionally, current research has not sufficiently addressed the mechanisms through which livelihood capital affects the social integration of relocated households.

With this in mind, the present paper, based on sustainable livelihood theory, utilizes a survey of 610 relocated households conducted by our research team in Liangshan Prefecture, Sichuan Province, in 2024. It explores in-depth the impact of livelihood capital on the social integration of relocated households and the mechanisms through which this effect occurs. Compared to previous studies, this paper makes the following potential contributions: First, while emphasizing objective livelihood capital, we introduce subjective psychological capital into the sustainable livelihood framework proposed by DFID, thereby expanding the traditional model of livelihood capital structure. Second, we examine livelihood risk as a channel variable through which livelihood capital affects social integration, identifying the pathways through which migrants integrate into society. Third, we investigate the heterogeneity of the impact of livelihood capital on social integration from the perspectives of resettlement methods, livelihood strategies, and gender, providing decision-making references to improve the social integration of different relocated groups.

2 Theoretical analysis and research hypotheses

2.1 The direct impact of livelihood capital on the social integration of relocated poverty alleviation farmers

The sustainable livelihood framework developed by DFID consists of five components: vulnerability context, livelihood capital, structural and process transformation, livelihood strategies, and livelihood outcomes (Yang et al., 2023; Zhang et al., 2024). In this framework, relocated households are seen as individuals making a living under the influence of vulnerability, using their livelihood capital to achieve survival and development. They are also subject to external policy support or constraints. Under the combined influence of these factors, relocated households choose different livelihood strategies to achieve optimal livelihood outcomes (Shang et al., 2023; Wu et al., 2022). The sustainable livelihoods theory integrates resources and capabilities from various domains—natural, material, human, social, and financial—and serves as the foundation for farmers to maintain and improve their livelihoods (Su et al., 2021; Zhang et al., 2024). Social integration of relocated households is a family-based migration behavior in which livelihood capital serves as a key resource. Differences in livelihood capital will inevitably affect the ability of relocated households to integrate into their new environments (Wang and Gao, 2022). On the one hand, livelihood capital provides economic stability and a sense of security, enabling relocated households to maintain a stable livelihood in their new environment. This economic stability is a prerequisite for social integration and reduces the risk of social exclusion and marginalization due to economic hardship (Mallick et al., 2020). Furthermore, a stable economic situation allows farmers to dedicate more time and energy to participating in community activities and establishing social relationships, thus enhancing social integration. On the other hand, livelihood capital enables relocated households to access information and resources, and through resource sharing, they are able to build a broader network of social relationships and obtain more social support, further promoting their integration into society (Azizi et al., 2017). In summary, the hypothesis is proposed:

> *H1:* Livelihood capital has a positive effect on social integration of relocated households.

2.2 The indirect impact of livelihood capital on social integration of relocated poverty alleviation farmers

According to sustainable livelihood theory, the livelihood process of relocated households is often accompanied by uncertainties, some of which stem from external factors such as environmental and social risks, while others arise from the

individuals themselves, such as health risks. These risks are collectively referred to as livelihood risks (Bouahom et al., 2004; Ma and Zhao, 2022). Once a household experiences a risk shock, it can severely affect the living standards of its members, even causing some relocated households to fall back into poverty overnight, thereby constraining their social integration (Vivekananda et al., 2014). Sustainable livelihood theory posits that the resources and endowments held by farmers, i.e., livelihood capital, influence and represent their ability to sustain their livelihoods, form the foundation of the livelihood process, and serve as the basis for resisting risk shocks and maintaining livelihood stability (Su et al., 2018). Different forms of livelihood capital have complex relationships with various livelihood risks, and the extent of livelihood capital affects the severity of these risks. Generally, the more abundant a household's livelihood capital, the more strategies it has to cope with livelihood risks (Siegel, 2005). The accumulation of livelihood capital in relocated households can mitigate and prevent livelihood risks, which might otherwise negatively impact social integration by affecting psychological wellbeing, access to resources, social capital, and adaptive capacities.

Livelihood risks are multidimensional, and this paper analyzes the role of livelihood risks in the process of social integration as influenced by livelihood capital, focusing on environmental, employment, and health risks. First, environmental risks refer to unfavorable factors and uncertainties that relocated households may encounter in their new environment, such as natural disasters, environmental pollution, and poor housing conditions (Su, 2017). Livelihood capital can impact environmental risks in multiple ways: the higher the livelihood capital, the stronger the economic and resource acquisition capabilities of relocated households, allowing them to improve living conditions and mitigate environmental risks (Su et al., 2019). Environmental risks can lead to health problems, economic losses, and psychological stress, which can hinder social interactions and participation, thus affecting social integration.

Secondly, employment risk refers to the unstable employment, uncertainty and insufficient employment opportunities that farmers face in the new urban environment (Kuang et al., 2020). On the one hand, livelihood capital enhances the adaptive capacity of relocated households, enabling them to cope with and mitigate employment risks more effectively (Zeng et al., 2021a). On the other hand, employment risks may lead to unstable economic income and restricted career development, limiting relocated households' economic capital accumulation and career development, which in turn affects their survival and development in towns and cities.

Finally, health risks refer to the health problems and medical challenges that relocated households may face in the new environment, which may include, but are not limited to, an increased incidence of diseases, lack of medical resources, insufficient health protection, and health problems brought about by changes in lifestyles (Zeng et al., 2021b). The accumulation of livelihood capital is conducive to increasing the health awareness of relocated households, enabling them to prevent and cope with health problems more effectively, and relocated households with higher financial capital are able to pay for healthcare and receive timely healthcare services (Zeng et al., 2021a); at the same time, health risks may lead to a decline in relocated households' labor capacity and a reduction in employment opportunities, limiting relocated households' capital accumulation and career development, which in turn affects their survival and development in towns and cities. In summary, the following hypotheses are proposed (Figure 1):

> *H2:* Livelihood capital indirectly contributes to the social integration of relocated households by reducing livelihood risks.
>
> *H2a:* Livelihood capital indirectly contributes to the social integration of relocated households by reducing environmental risks.
>
> *H2b:* Livelihood capital indirectly contributes to the social integration of relocated households by reducing employment risks.
>
> *H2c:* Livelihood capital indirectly promotes social integration of relocated households by reducing health risks.

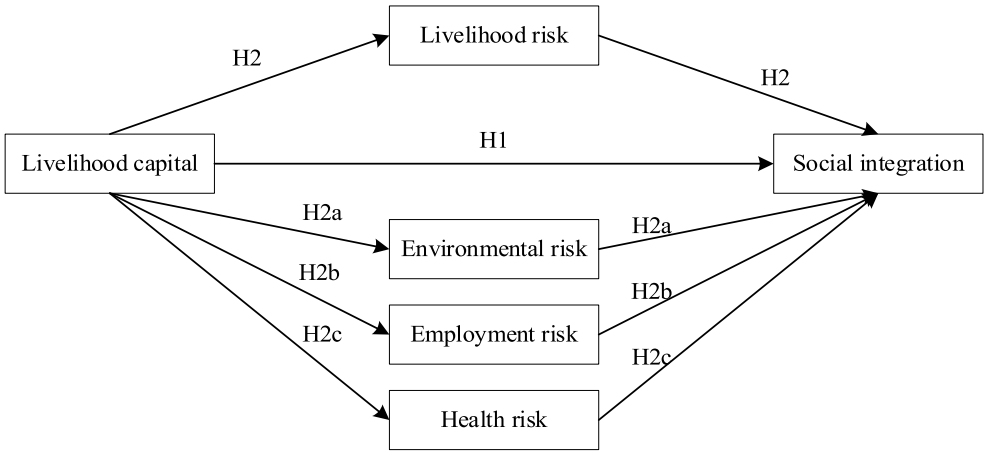

FIGURE 1
Theoretical analysis framework.

3 Materials and methods

3.1 Data sources

The data used in this study are derived from field research conducted in Liangshan Prefecture, Sichuan Province, China, between January and March 2024. To ensure representative coverage of resettlement patterns, we employed a stratified purposive sampling method to select five counties from Liangshan Prefecture's 17 administrative units. The selection criteria prioritized counties with resettlement rates exceeding 15%, aiming to capture regions where demographic shifts most significantly impacted socioeconomic dynamics. This approach balanced geographic diversity and data richness while aligning with the study's focus on high-impact resettlement areas. The final sample included Ganluo, Butuo, Yuexi, Meigu, and Zhaojue counties. Next, a combination of stratified and random sampling methods was applied to account for the differences in economic development levels across various regions, as well as the varying characteristics of relocated farmers. This approach aimed to select a diverse range of relocated farmer samples to ensure that the survey results would more closely reflect reality. In each county, 1–3 resettlement areas were randomly selected, with 50–80 households chosen from each area. A total of 661 questionnaires were collected, and after excluding invalid responses, 610 valid questionnaires were retained, yielding a validity rate of 92%.

3.2 Variable selection

3.2.1 Explained variables

The dependent variable in this study is the social integration of relocated farmers. Social integration is a multidimensional concept, and existing literature has yet to reach a consensus on the specific dimensions for its measurement. Based on prior research (Jia et al., 2022; Lin et al., 2020; Xie et al., 2022; Yang et al., 2020), this paper measures the level of social integration among relocated farmers across four dimensions: economic integration, social interaction integration, cultural integration, and psychological integration. Specifically, economic integration includes four aspects: employment status, income stability, income level, and consumption patterns. Social interaction integration is assessed by participation in electoral activities, resettlement community activities, the degree of mutual assistance with local residents, and familiarity with local residents. Cultural integration is measured by the mastery of the local language, funeral customs, marriage views, and daily living practices. Psychological integration includes three dimensions: identity recognition, long-term residence, and experiences of discrimination (Table 1). Factor analysis was used to measure the level of social integration. The Kaiser-Meyer-Olkin (KMO) value was 0.794, Bartlett's test was significant at the 1% level, and the cumulative variance contribution rate was 66.512%, indicating the appropriateness of factor analysis.

3.2.2 Core independent variables

The core independent variable in this study is the livelihood capital of relocated farmers. In addition to the five types of livelihood capital proposed by the UK Department for International Development (DFID), this paper incorporates the specific context of relocated farmers in Liangshan Prefecture by adding a psychological capital dimension. Therefore, livelihood capital is measured across six dimensions: natural capital, material capital, human capital, social capital, financial capital, and psychological capital. The specific index system is presented in Table 2. The entropy method was used to calculate the livelihood capital index.

3.2.3 Mechanism variables

The mediating variable is livelihood risk, with reference to Su et al. (2021) and Hu and Wen (2021). This study measures livelihood risk based on three dimensions: environmental risk, employment risk, and health risk. Environmental risk is primarily assessed through natural disasters and the quality of the community environment; health risk is gauged based on family members' health conditions and inadequate medical facilities; and employment risk is measured by poor employment outcomes and limited access to job information. The entropy method was used to calculate indices for environmental risk, employment risk, health risk, and overall livelihood risk.

3.2.4 Control variables

The social integration of relocated farmers is influenced by a variety of factors. To control for other potential variables that may affect the regression results, control variables were selected from three categories: personal characteristics, family characteristics, and resettlement characteristics (Fei et al., 2023; Ma et al., 2023; Zhou et al., 2022). Personal characteristics include gender, age, education level, health status, and participation in skills training. Family characteristics consist of household size, labor force participation rate, whether the household is included in government monitoring, and whether the family raises livestock. Resettlement characteristics include duration of residence, distance from the original place of residence, the location of the resettlement area, and the distance to the nearest central town. The variable definitions and descriptive statistics involved in the empirical analysis of this paper are shown in Table 3.

3.3 Research methodology

3.3.1 Benchmark regression

In the paper, the OLS regression model is used to estimate the impact of social integration on the household income of relocated farmers. The specific model is as follows:

$$Y_i = \alpha + \alpha_1 X_1 + \alpha_2 Control_i + \varepsilon_i \quad (1)$$

In equation 1, the explained variable Y_i denotes the level of social integration of relocated households, and the core explanatory variable X_i denotes the level of livelihood capital of relocated households. The control variable $Control_i$ represents the observable characteristics of individual characteristics, family characteristics and resettlement characteristics of the relocated households; ε_i is the random error term.

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TABLE 1 Index system of social integration.

Dimension	Index	Interpretation of indicators	Minimum value	Maximum value	Mean value	Standard deviation
Economic integration	Employment status	Satisfaction with the current employment situation	1	5	3.264	0.839
	Consumption status	What is the household's level of consumption in the place of relocation	1	5	2.762	0.794
	Income stability	Whether the family has a stable income	0	1	0.830	0.376
	Income level	Can the family's economic income meet the family's needs in the place of relocation	1	5	3.072	0.877
Social interaction integration	Settlement activities	Level of interest in various activities organized by the community	1	5	3.762	0.754
	Election activities	Number of election campaigns for the community or village council in the place of relocation	1	5	3.759	0.850
	Degree of mutual assistance with the local residents	The degree of mutual assistance with other residents of the community	1	5	4.052	0.620
	Familiarity with the local residents	The level of mutual familiarity with other residents in this community	1	5	4.136	0.606
Cultural integration	Level of mastery of local dialects	Level of mastery of local dialects	1	5	4.031	1.275
	Funeral customs	The degree of adaptation to the burial customs in the place of relocation	1	5	4.280	0.740
	Marriage concepts	Level of acceptance of the concept of marriage in the place of relocation	1	5	4.269	0.704
	Diet and daily life	The degree of habituation to eating and living in the place of relocation	1	5	4.381	0.718
Psychological integration	Identity	Whether you agree that you are already a resident of the town	1	5	3.761	0.927
	Long-term residence	Whether you intend to reside permanently in the place of relocation	0	1	0.879	0.327
	Degree of discrimination	The level of discrimination felt in the place of relocation	1	5	4.536	0.762

3.3.2 Quantile regression

Since the OLS regression model focuses on the mean value and the estimation results are susceptible to outliers, the distribution pattern of the impact of livelihood capital on the social integration of relocated households cannot be obtained. In order to further analyze the effect of livelihood capital on the social integration of relocated households at different quartiles, the following quantile regression model is constructed as follows (Neira et al., 2019):

$$Q_{i\theta}\left(Y_i \middle| X_i\right) = X_i\alpha_{i\theta} + \varepsilon_{i\theta} \tag{2}$$

In equation 2, $\alpha_{i\theta}$is the coefficient estimate and $Q_{i\theta}\left(Y_i \middle| X_i\right)$ denotes the conditional quantile corresponding to the quantile θ given the explanatory variable X_i.

3.3.3 Mediated effects regression

This paper adopts a stepwise analysis method to explore the possible mediating effects of livelihood capital on the social integration of relocated households from the overall and sub dimensions of livelihood risk, and sets up the following mediating effect model (Wen and Yu, 2014):

$$Y = \gamma_0 X_i + \gamma_1 Control_i + \sigma_{1i} \tag{3}$$

$$M_i = \delta_0 X_i + \delta_1 Control_i + \sigma_{2i} \tag{4}$$

$$Y_i = \lambda_1 X_i + \lambda_2 M_i + \lambda_3 Control_i + \sigma_{3i} \tag{5}$$

In the above equations 3–5, Y_i is the social integration of relocated households, X_i is the livelihood capital, M_i denotes the mediating variable, $Control_i$ is the control variable, and$\sigma_{1i}, \sigma_{2i}, \sigma_{3i}$ is the random error term. The coefficient γ_0 is the total effect of livelihood capital on the social integration of relocated households. The coefficient δ_0 is the effect of livelihood capital on the mediating variable. The coefficient λ_2 is the effect of the mediating variable on

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TABLE 2 Indicator system of livelihood capital.

Dimension	Index	Interpretation of indicators	Minimum value	Maximum value	Mean value	Standard deviation
Natural capital	Cultivated area	Actual area of household cultivated land (mu)	0	108	9.112	8.832
	Quality of cultivated land	Overall quality of household arable land	1	5	3.108	0.925
	Forest land area	Actual area of family forest land (mu)	0	80	4.763	6.481
Material capital	Road condition	Convenience of community roads in the relocation area	1	5	4.370	0.588
	Housing area	Family housing area (square meters)	30	150	91.390	16.179
	Quantity of durable consumer goods	Number of consumer durables such as TVs, washing machines, refrigerators, computers, electric stoves, etc., owned by households (pieces)	1	25	8.175	2.148
Human capital	Number of laborers	Actual number of laborers in the household (persons)	1	9	3.105	1.446
	Educational level	Average literacy level of family members	1	4	1.981	0.495
	Health status	Average health status of family members	2	5	4.080	0.426
Social capital	Relationship with cadres	Relationships with community or village officials	1	5	4.061	0.602
	Level of trust	Level of trust with the local population	1	5	4.154	0.589
	Number of relatives	Number of relatives able to help in case of family difficulties	0	35	5.311	5.753
Financial capital	Deposit	How much money do you have at home	1	5	2.116	0.849
	Difficulty in lending	Ease of obtaining funds from financial institutions	1	5	2.298	0.897
	Difficulty of borrowing	The ease of finding friends and family to borrow money from	1	5	2.354	0.814
Psychological capital	Self-confidence	The level of confidence in doing things	1	5	3.639	0.652
	Future expectations	Expectations for future improvements in life	1	5	3.611	0.817
	Strong and brave	The level of strength and courage when facing difficulties in life	1	5	3.682	0.631

the social integration of relocated households after controlling for the effect of livelihood capital; the coefficient λ_1 is the direct effect of livelihood capital on the social integration of relocated households after controlling for the effect of the mediating variable. In this mediating effect, the mediating effect is the indirect effect, and the mediating effect is equal to the product of the coefficient δ_0 and the coefficient λ_2, denoted as $\delta_0\lambda_2$, and the weight of the mediating effect is measured by $\delta_0\lambda_2 / \gamma_0$.

4 Results

4.1 Analysis of baseline regression results

Table 4 presents the results of estimating the impact of livelihood capital on the social integration of relocated households using both the OLS model and the quantile regression model. According to the OLS regression results, livelihood capital passes the 1% significance level test, with a positive coefficient, indicating that livelihood capital significantly increases the social integration level of relocated households. Specifically, for each one-unit increase in livelihood capital, the social integration level of relocated households rises by 55.32%. This confirms Hypothesis 1.

The quantile regression results also show that livelihood capital significantly improves the social integration of relocated households, regardless of the quantile point used for the sample regression. At the 25th, 50th, 75th, and 95th quantiles, the effects of livelihood capital on the social integration of relocated households are 0.538, 0.421, 0.408, and 0.346, respectively. These findings suggest that the effect of livelihood capital on social integration diminishes as the level of social integration increases. The likely reason is that relocated households with lower social integration levels have a more urgent need for livelihood capital. An increase in livelihood capital significantly improves their economic situation and social relationships, thus fulfilling their basic needs and substantially enhancing their social integration (Peng and Ling, 2019). As their level of social integration improves, their basic needs are better met, and further increases in livelihood capital result in diminishing marginal effects on social integration, leading to a weaker impact.

4.2 Endogenous treatment

The empirical model discussed above may suffer from endogeneity issues, such as mutual causality or omitted variable bias, when estimating the impact of livelihood capital on social integration. To

TABLE 3 Description of variables and descriptive statistics.

Variable type	Variable name	Variable meaning and assignment	Mean value	Standard deviation
Explained variable	Social integration	The factor analysis method measured	0	0.504
Core explanatory variable	Livelihood capital	Measured by the entropy method	2.228	0.391
Mediating variable	Livelihood risk	Measured by the entropy method	0.829	0.361
	Environmental risk	Measured by the entropy method	0.143	0.151
	Employment risk	Measured by the entropy method	0.415	0.182
	Health risk	Measured by the entropy method	0.272	0.179
Personal characteristics	Gender	Gender of head of household: male = 1, female = 0	0.818	0.386
	Age	Age of head of household (years)	47.383	13.136
	Educational level	Educational level of the head of household: below elementary school = 1, elementary school = 2, junior high school = 3, secondary or high school = 4, college and above = 5	1.849	0.745
	Health status	Physical health of the head of household: very unhealthy = 1, unhealthy = 2, average = 3, healthy = 4, very healthy = 5	3.926	0.736
	Skills training	Whether the head of household has participated in vocational skills training: yes = 1, no = 0	0.659	0.474
Family characteristics,	Family size	Total household size (persons)	5.605	1.761
	Labor force share	Number of household laborers/total household size	0.572	0.230
	Whether to monitor households	Yes = 1, no = 0	0.121	0.327
	Whether to raise livestock	Yes = 1, no = 0	0.313	0.464
Resettlement characteristics	Residence time	Time to place of relocation (years)	3.767	0.883
	Distance from place of relocation	Distance between current place of residence and place of removal (km)	37.497	30.851
	Placement location	County resettlement = 1, township resettlement = 0	0.761	0.427
	Distance to center of town	Distance from current residence to central town (km)	2.224	1.503

address these potential endogeneity problems, suitable instrumental variables need to be selected. Drawing on previous studies (Wang et al., 2021), we choose "the mean livelihood capital of other relocated households in the same resettlement community" and "the altitude of the relocation site" as instrumental variables for social integration. In a community, where social interactions are often based on acquaintances, the "peer effect" is prevalent. Therefore, the livelihood capital of relocated households is influenced by the mean livelihood capital of other relocated households in the same community, fulfilling the correlation requirement for instrumental variables. Additionally, the livelihood capital of other relocated households does not directly affect the social integration of a given household, satisfying the exogeneity condition. High-altitude areas generally face harsh climates, poor transportation, limited resources, and underdeveloped infrastructure, all of which constrain local economic activities and development opportunities, thus affecting the accumulation of livelihood capital for farmers. Consequently, the altitude of the relocation site is relevant as an instrumental variable. At the same time, the altitude itself does not directly impact the social integration level of relocated households in their new residence, thus fulfilling the exogeneity requirement of the instrumental variable.

Prior to conducting the regression, we tested the validity of the selected instrumental variables. The results of the non-identification test show that the Kleibergen-Paap rk LM statistic is 27.21, with a corresponding *p*-value of 0.000, rejecting the null hypothesis of "non-identification." For the weak instrument test, the Cragg-Donald Wald statistic is 16.89, which exceeds the critical value of 11.59 at the 10% bias level, thereby rejecting the hypothesis of "weak instruments." The Hansen J statistic for the over-identification test gives a *p*-value greater than 0.1, meaning we fail to reject the null hypothesis that "all instrumental variables are exogenous." This confirms that the instrumental variables meet the exogeneity requirement.

Table 5 presents the model parameters after including the instrumental variables in the two-stage ordinary least squares estimation. The second-stage regression results show that after addressing potential endogeneity issues, the coefficient of livelihood capital on the social integration of relocated households is 1.519, which is statistically significant at the 1% level. Although this estimated coefficient is larger than the one obtained from the baseline regression, the sign and significance remain consistent. This suggests that the conclusion that increased livelihood capital promotes the social integration of relocated households is robust, even after accounting for omitted variables and potential reverse causality between livelihood capital and social integration.

4.3 Robustness tests

Three methods are used to conduct robustness tests on the baseline regression results. First, we replace the dependent

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TABLE 4 Impact of livelihood capital on social integration of relocated households.

Variable name	OLS and quantile regression				
	OLS	0.25	0.50	0.75	0.95
Livelihood capital	0.553*** (0.059)	0.538*** (0.091)	0.421*** (0.074)	0.408*** (0.071)	0.346*** (0.080)
Gender	0.001 (0.044)	0.068 (0.079)	−0.014 (0.059)	0.031 (0.058)	0.072 (0.051)
Age	−0.002 (0.002)	−0.002 (0.002)	−0.002 (0.002)	0.001 (0.002)	0.003 (0.002)
Educational level	0.024 (0.029)	0.053 (0.046)	0.044 (0.030)	0.025 (0.025)	0.041 (0.032)
Health status	0.052** (0.024)	0.006 (0.036)	0.063* (0.034)	0.077*** (0.028)	0.080*** (0.029)
Skills training	0.159*** (0.036)	0.219*** (0.057)	0.160*** (0.048)	0.120*** (0.045)	0.134*** (0.042)
Family size	−0.009 (0.011)	−0.003 (0.017)	−0.011 (0.015)	−0.017 (0.013)	−0.020 (0.016)
Labor force share	−0.124 (0.093)	−0.189 (0.125)	−0.186 (0.124)	−0.065 (0.106)	−0.252** (0.103)
Whether to monitor households	−0.059 (0.059)	−0.104 (0.089)	−0.058 (0.077)	−0.059 (0.066)	0.066 (0.061)
Whether to raise livestock	0.015 (0.042)	0.021 (0.067)	−0.017 (0.053)	0.054 (0.055)	0.114*** (0.043)
	0.060*** (0.022)	0.029 (0.035)	0.081*** (0.031)	0.077*** (0.026)	0.070** (0.027)
Distance from place of relocation	−0.001 (0.001)	0.001 (0.001)	−0.001 (0.001)	−0.001* (0.001)	−0.001 (0.001)
Location of settlement	−0.107*** (0.039)	−0.210*** (0.077)	−0.156*** (0.051)	−0.050 (0.043)	−0.010 (0.047)
Distance to center of town	−0.019* (0.011)	−0.028* (0.016)	−0.037** (0.016)	0.003 (0.021)	0.011 (0.018)
Constant term	−1.475*** (0.180)	−1.405*** (0.294)	−1.131*** (0.266)	−1.205*** (0.236)	−0.952*** (0.238)
R^2	0.346	0.204	0.185	0.186	0.251
Observations	610	610	610	610	610

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

TABLE 5 Instrumental variable test results.

Variable name	Livelihood capital	Social integration
	The first stage	The second stage
Livelihood capital		1.519*** (0.289)
Mean value of livelihood capital of other relocated households in the same resettlement community	0.824*** (0.164)	
Altitude of the relocation site	0.066*** (0.022)	
Control variable	Controlled	Controlled
Constant term	−0.995*** (0.378)	−2.306** (0.309)
F-value	29.82	
R^2	0.416	
Observations	610	610

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

variable, following the approach of Qian et al. (2021), by using "whether they intend to live permanently at the relocation site" instead of social integration. Since the dependent variable is binary, we use a binary logit model for empirical analysis. Model (1) in Table 6 reports the robustness test results using the alternative dependent variable. The results show that livelihood capital is significantly and positively associated with social integration after the substitution, indicating that the main findings of this study are robust.

Second, we modify the measurement method for the variables. In the baseline regression, the level of social integration is calculated using factor analysis. To avoid potential biases due to differences in measurement methods, we re-estimate the social integration level using the entropy method. Model (2) in Table 6 presents the regression results based on this alternative measurement. The results are consistent with those of the baseline regression, with livelihood capital continuing to have a significant positive impact on social integration at the 1% level, further confirming the robustness of the main findings.

Third, we alter the sample by excluding elderly individuals, who may face additional health issues, lower labor participation, and different social engagement patterns (Zhang and Sun, 2024). We exclude households where the head of the household is over 60 years old and re-estimate the regression. The results, shown in Model (3) of Table 6, indicate that the relationship between the dependent and independent variables remain significantly positive, and the results are consistent with those of the baseline regression, confirming the robustness of the original model.

TABLE 6 Robustness test.

Variable name	Model (1)	Models (2)	Models (3)
	Substitution of explanatory variables	Changing the measurement methodology	Changing the sample size
Livelihood capital	0.161** (0.501)	0.162*** (0.015)	0.534*** (0.060)
Control variable	Controlled	Controlled	Controlled
Constant term	1.002*** (1.471)	0.317*** (0.053)	−1.522*** (0.194)
R^2	0.155	0.354	0.322
Sample size	610	610	509

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

4.4 Mechanism analysis

As discussed in the previous section, the livelihood risks faced by relocated households include three main aspects: environmental risk, employment risk, and health risk. Therefore, to further analyze the mediating role of livelihood risks, this paper first examines the mechanism through which livelihood capital affects the social integration of relocated households from the overall livelihood risk perspective. It then delves deeper into the mediating roles of environmental risk, employment risk, and health risk.

Table 7 presents the estimated impact coefficients after incorporating the mechanism variables. Model (1) shows that the impact coefficient of livelihood capital on livelihood risk is −0.378, which is statistically significant at the 1% level. This indicates that livelihood capital has a significant inhibitory effect on the livelihood risk of relocated households. Model (2) reveals that both livelihood capital and livelihood risk have significant impacts on the social integration of relocated households at the 1% level. Moreover, the coefficient for livelihood risk is negative, suggesting that livelihood risk plays a significant mediating role in the effect of livelihood capital on the social integration of relocated households. In other words, livelihood capital promotes the social integration of relocated households by reducing livelihood risks. In terms of sub-dimensions, environmental risk, employment risk, and health risk each play a partial mediating role in the relationship between livelihood capital and social integration.

To ensure the robustness and reliability of the mediation results, this paper further employs the Bootstrap and Sobel tests to assess the mediating role of livelihood risk (Gong et al., 2024). The results are shown in Table 8. According to the Sobel test, the direct and indirect effects of livelihood risk, environmental risk, employment risk, and health risk are all significant at the 1% level. This confirms that livelihood risk plays a significant mediating role in the process by which livelihood capital affects the social integration of relocated households. It is important to note that the Bootstrap test for mediation effects is based on whether the 95% confidence interval contains 0. If the interval does not contain 0, the mediation effect is present; if it does contain 0, the mediation effect does not exist. The Bootstrap results indicate that the confidence interval for livelihood risk does not include 0, which further supports the conclusion that livelihood risk has a significant mediating effect in the relationship between livelihood capital and the social integration of relocated households. Thus, hypotheses H2, H2a, H2b, and H2c are validated.

From a comprehensive perspective, livelihood risk plays a crucial role in the process through which livelihood capital influences the social integration of relocated households. It is a key factor in evaluating whether migrants can achieve "stability, integration, and gradual prosperity" after relocation. Among these, environmental risk, employment risk, and health risk each play a partial mediating role, with their mediation effects accounting for 10.32, 31.42, and 23.42%, respectively. This suggests that, in addition to directly affecting the social integration of relocated households, livelihood capital also improves social integration by reducing environmental, employment, and health risks.

5 Further discussion

Although the previous analysis has verified the positive role of livelihood capital in promoting the social integration of relocated households, this study treats relocated households as a whole in the model. However, there are significant differences between townships and urban areas in terms of resource allocation, employment opportunities, education, healthcare, and other factors. These differences result in varying environments for the social integration of relocated households in different resettlement areas, which may lead to differences in the effect of livelihood capital on social integration (Gu et al., 2022). At the same time, the livelihoods of the study subjects in this paper include agriculture-based, labor-based, and mixed livelihoods, and the livelihood capital and social integration of households with different livelihood strategies may vary significantly (Chen and Gan, 2024). Furthermore, relocated groups themselves also exhibit substantial differences in individual characteristics, such as gender (Peng et al., 2022). Therefore, the effect of livelihood capital on the social integration of different migrant groups may also differ.

Based on this, this paper conducts heterogeneity analysis by selecting relocated households based on different resettlement locations, livelihood strategies, and genders, aiming to comprehensively understand the heterogeneity of influencing factors and to uncover the characteristics and underlying causes of social integration of relocated households in different contexts. The analysis results are presented in Table 9.

From the perspective of different resettlement locations, compared to urban resettlements, the positive effect of livelihood capital on the social integration of relocated households in townships is more pronounced. This is likely because township resettlement areas are generally closer to original rural communities, and cultural practices and lifestyles are more similar. As a result, relocated households find it easier to identify with the local culture and adapt to the community, making social integration less challenging (Wang et al., 2023). In terms of different livelihood strategies, compared to

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TABLE 7 Mediated effects test.

Variable name	Model (1)	Models (2)	Models (3)	Models (4)	Models (5)	Models (6)	Models (7)	Models (8)
	Livelihood risk	Social integration	Environmental risk	Social integration	Employment risk	Social integration	Health risk	Social integration
Livelihood capital	−0.378*** (0.043)	0.292*** (0.055)	−0.052*** (0.018)	0.497*** (0.059)	−0.168*** (0.022)	0.379*** (0.057)	−0.158*** (0.023)	0.424*** (0.057)
Livelihood risk		−0.692*** (0.041)						
Environmental risk				−1.096*** (0.099)				
Employment risk						−1.034*** (0.101)		
Health risk								−0.816*** (0.087)
Control variable	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Constant term	1.694*** (0.140)	−0.302* (0.178)	0.083 (0.170)	−1.383*** (0.170)	0.991*** (0.063)	−0.450** (0.196)	−0.620*** (0.074)	−0.968*** (0.180)
R^2	0.231	0.535	0.062	0.447	0.311	0.442	0.161	0.417
Sample size	610	610	610	610	610	610	610	610

*** denotes significant at the 1% statistical level; robust standard errors are in parentheses.

non-agricultural relocated households, livelihood capital has a more significant impact on the social integration of agricultural and part-time relocated households. This is likely due to the fact that agricultural and part-time households have more diverse income sources, including both agricultural and non-agricultural income. This diversified livelihood strategy enhances their ability to withstand economic fluctuations, and an increase in livelihood capital can more effectively support their economic activities, thereby improving their social integration. From a gender perspective, livelihood capital has a positive effect on the social integration of both male and female relocated households, but the effect is more pronounced for female-headed households. Women are more likely to take on responsibilities related to family affairs and maintaining social relationships during relocation. As a result, they tend to participate more actively in community activities and establish new social networks in the resettled community.

6 Conclusion and suggestion

Based on the theory of sustainable livelihoods and social integration, this paper constructs an analytical framework and uses data from a 2024 survey of 610 relocated poverty alleviation households in China to investigate the relationship between livelihood capital, livelihood risk, and the social integration of relocated farmers, employing a mediation model. The main conclusions are as follows:

(1) Livelihood capital has a significant positive effect on the social integration of relocated households. For every one-unit increase in livelihood capital, the social integration level of relocated households increases by 55.32%. The conclusion remains valid even after addressing potential endogeneity. The quantile analysis shows that at the 0.25, 0.50, 0.75, and 0.95 quantiles, the impact of livelihood capital on the social integration of relocated farmers is significantly positive at the 1% statistical level. Moreover, as the quantile increases (0.25 → 0.95), the coefficient of livelihood capital's effect on social integration decreases (0.538 → 0.421 → 0.408 → 0.346), indicating that as the level of social integration among relocated farmers improves, the effect of livelihood capital on social integration gradually diminishes.

(2) Livelihood risk is one of the key mechanisms through which livelihood capital influences the social integration of relocated households. From the perspective of overall livelihood risk, livelihood capital indirectly promotes the social integration of relocated households by reducing livelihood risks, and livelihood risk plays a significant mediating role in this process. The results of the sub-dimension tests indicate that livelihood capital can reduce environmental risk, employment risk, and health risk, thereby indirectly enhancing the social integration of relocated households. Environmental risk, employment risk, and health risk each significantly mediate the relationship between livelihood capital and social integration.

(3) The impact of livelihood capital on the social integration of relocated households shows significant heterogeneity across different resettlement locations, livelihood strategies, and gender. In terms of resettlement location, compared with urban

TABLE 8 Robustness test results based on Sobel and Bootstrap.

Intermediary path	Sobel test		Bootstrap test	Proportion of intermediary effects
	Direct effect	Indirect effect	95% confidence interval	
Livelihood risk	0.292*** (0.049)	0.261*** (0.034)	[0.2819, 0.5147]	47.25%
Environmental risk	0.497*** (0.050)	0.057*** (0.022)	[0.3010, 0.5442]	10.22%
Employment risk	0.379*** (0.053)	0.174*** (0.027)	[0.0611, 0.2244]	31.42%
Health risk	0.424*** (0.054)	0.129*** (0.023)	[0.1462, 0.3344]	23.31%

*** indicates significant at the 1% statistical level.

TABLE 9 Heterogeneity analysis: resettlement location, livelihood strategies and gender.

Variable name	(1)	(2)	(3)	(4)	(5)	(6)
	Township placement	Urban resettlement	Agricultural and part-time type	Non-agricultural	Male	Females
Livelihood capital	0.301*** (0.083)	0.618*** (0.076)	0.734*** (0.148)	0.473*** (0.056)	0.502*** (0.065)	0.817*** (0.116)
Control variable	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Constant term	−0.797*** (0.260)	−1.754*** (0.205)	−1.509*** (0.374)	−1.390*** (0.193)	−1.396*** (0.191)	−2.089*** (0.375)
R^2	0.241	0.352	0.422	0.354	0.331	0.548
Experienced *p*-value	0.007***		0.029**		0.027**	
Sample size	146	464	174	436	499	111

** and *** denote significant at the 5 and 1% statistical levels, respectively; robust standard errors are in parentheses; "empirical *p*-values" are used to test the significance of differences in the coefficients between groups and were obtained by auto-sampling (Bootstrap) 1,000 times.

resettlement, livelihood capital has a more pronounced effect on the social integration of relocated households in township resettlements. Regarding livelihood strategies, livelihood capital has a greater impact on the social integration of agricultural and part-time relocated households than on non-agricultural relocated households. In terms of gender, livelihood capital has a positive effect on the social integration of relocated households regardless of gender, with a stronger effect for female relocated households.

Based on the above research conclusions, this paper draws the following important policy insights: First, the positive role of livelihood capital in promoting the social integration of relocated households suggests the need for a multi-dimensional approach to improving their livelihood capital. Policymakers should increase investments in human capital, strengthen the construction of social capital, improve material capital support, enhance access to financial capital, and focus on accumulating psychological capital. This will help leverage the full potential of livelihood capital in promoting the social integration of relocated households, ensuring the long-term effectiveness and sustainable development of relocation policies for poverty alleviation. Second, given the mediating role of livelihood risk in the impact of livelihood capital on the social integration of relocated households, policymakers should design and implement multi-layered livelihood risk management strategies. These strategies should include providing safeguards such as employment insurance, medical insurance, and social insurance, as well as establishing emergency funds to help relocated households cope with sudden risks and disasters, thereby reducing their economic and life pressures. Finally, the heterogeneity in the impact of livelihood capital on the social integration of relocated households suggests the need for tailored policies that take into account different resettlement locations, livelihood strategies, and genders. Policies should be designed to reflect the specific needs of different groups, promoting social integration through a combination of targeted measures.

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 author.

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and the institutional requirements.

Author contributions

CZ: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Software, Writing – original draft, Writing – review & editing. MT: Data curation, Formal analysis, Resources, Software, Supervision, Writing – original draft. CW: Conceptualization, Supervision, Writing – review & editing.

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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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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2025.1537141/full#supplementary-material

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