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Original Research

Research on the Impact of Livelihood Infrastructure on Income Inequality among Farmhouseholds: A Quasi-Natural Experiment from the Drinking Water Transformation

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Abstract

This study utilizes data from the China Family Panel Studies (CFPS), spanning five rounds of surveys from 2010 to 2018, as a sample. Using the deprivation index to measure income inequality among farmhouseholds, a quasi-natural experiment is established through a "progressive" difference-in-differences (DID) model to empirically examine the impact of livelihood infrastructure on income inequality among farmhouseholds, specifically focusing on the transformation of drinking water. The findings reveal that the transformation of drinking water, as a component of livelihood infrastructure, significantly reduces income inequality among farmhouseholds. The robustness of the research conclusions is validated through a series of tests, including the parallel trends test, the placebo test, and the PSM-DID. Mechanism tests indicate that the transformation of drinking water primarily reduces income inequality among farmhouseholds by enhancing their household health capital and psychological capital. Furthermore, further analysis demonstrates an inverted U-shaped non-linear relationship between the impact of drinking water transformation on income inequality and the per capita net income of households. The impact of drinking water transformation on income inequality is more pronounced among households with land ownership and households where the head engages in farming activities.

Keywords: livelihood infrastructure, drinking water transition, income inequality, difference-in-differences model

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Introduction

With the comprehensive victory of China's poverty alleviation campaign and the successful eradication of absolute poverty, relative poverty has gained increasing attention. Currently, the absolute income of rural residents who have emerged from poverty remains at a relatively low level, and the problem of relative income inequality among farmhouseholds persists. Therefore, it is worth continued attention to address the issue of reducing income inequality among rural households. Strengthening rural infrastructure construction can attract social investment, promote overall economic growth, develop non-agricultural sectors, and increase farmers' income. Particularly for poverty-stricken areas, infrastructure construction can play a more significant role in boosting farmers' income and alleviating income disparities. In this setting, to fulfill the aspirations of rural inhabitants for an enhanced quality of life, examining the influence of livelihood infrastructure development on household income disparities carries substantial practical importance in reducing relative income inequalities among agricultural households, reinforcing the accomplishments of poverty reduction initiatives, and advancing rural agricultural modernization.

Currently, measurements of income inequality focus on the overall study of population groups, including methods such as the income Gini coefficient, the Atkinson inequality index [1], and multidimensional poverty [2]. However, these methods fail to adequately measure income inequality among individual rural households from a micro perspective. To better explore the issue of relative income inequality among households, this paper introduces the concept of a relative deprivation index to measure income inequality among farmhouseholds.

The deprivation index is a measurement based on quasi-ordering and inequality judgments. It possesses strict preferences and transitivity, providing a clear ranking of individual-level income inequality and thus more accurately reflecting the micro characteristics behind income differentiation. This concept originates from the "conflict" theory in sociology. Broadly speaking, relative deprivation refers to the subjective psychological state of unfairness, harm, and dissatisfaction that individuals experience after comparing themselves with others. In a narrow sense, income deprivation refers to the objective economic state of relative deprivation in income. After introducing the concept of a "reference group" in the research, it was found that the income of other members within the reference group is negatively correlated with one's own well-being. This is known as the "income-happiness" paradox, also referred to as the "relative comparison effect" or "relative deprivation effect" [3], reflecting the state of individual-level income inequality [4]. By introducing the relative deprivation index, this paper can more accurately reflect the micro characteristics behind income differentiation, enabling a better exploration of the issue of relative income inequality among households.

With regard to examining the measurement of income inequality among rural residents, scholars have begun to focus on the factors influencing income inequality among rural residents. Currently, both domestic and international scholars have approached this topic from macro and micro perspectives. From a macro perspective, factors such as economic growth [5], land tenure systems [6], inclusive digital finance [7], regional geographic disparities [8], government investment [9], capital stock, human capital, and rural industrialization [10] have significant effects on income inequality among rural residents. From a micro perspective, factors such as land transfer within household families [11], non-agricultural employment of the labor force [12], as well as other household characteristics including material capital, human capital, social capital, and characteristics of household heads such as industry, occupation, and politics, all have certain impacts on income inequality among farmhouseholds [13]. Considering the important impact of public infrastructure on promoting economic growth, improving livelihoods, and increasing farmers' income, scholars have recently started to pay attention to the influence of infrastructure on income inequality among farmhouseholds, particularly focusing on transportation infrastructure and digital infrastructure. Specifically, studies have found that improvements in the accessibility of tap water, electricity, and road networks can significantly alleviate income inequality in rural areas [14]. After examining the impact of convenient transportation infrastructure on income inequality among farmhouseholds, it was discovered that the facilitation of transportation infrastructure improves income inequality by accelerating urbanization processes and reducing the per capita output gap between industry and agriculture [15]. The development of infrastructure such as the Internet has also mitigated income inequality among farmhouseholds [16]. It is evident that infrastructure construction plays a crucial role in improving income inequality among farmhouseholds. Therefore, infrastructure construction plays an important role in alleviating income inequality in rural areas by promoting economic growth, improving livelihoods, and increasing farmers' income.

A review of existing literature reveals that studies on factors affecting income inequality among rural households primarily focus on household and individual characteristics, as well as infrastructure. These preceding studies offer substantial theoretical backing and research insights for this paper, enabling a deeper comprehension of the diverse factors contributing to income disparities among rural households. Nevertheless, water is a fundamental resource for human survival and development, and the improvement of water supply facilities not only affects the quality of life of rural households but also potentially impacts various aspects such as production and daily life. Surprisingly, there are limited studies that have delved into income inequality among rural households through the lens of water supply infrastructure's impact on people's livelihoods. As the material foundation of economic development, livelihood public infrastructure can contribute to increasing farmhousehold income by improving agricultural productivity, enhancing rural living standards, and reducing rural living costs. Rural water supply projects, being infrastructure endeavors focused on securing livelihoods, gaining public favor, and fostering economic growth, hold a pivotal position in reinforcing and broadening the progress made in poverty alleviation, as well as propelling rural agricultural and overall modernization. Data from the Ministry of Water Resources indicates that by 2022, the access rate of tap water in China's rural regions had climbed to 87%, with 56% of the rural populace being served by extensive water supply projects. Significant progress has been made in rural water supply. However, due to the complexity of China's national and international water conditions, there are still imbalances and insufficiencies in the development of regional water supply and public infrastructure. Weaknesses remain in rural areas; therefore, steady promotion of livelihood infrastructure construction, particularly focusing on rural water supply projects, is imperative to guarantee water safety and fully satisfy the production and household water demands of rural inhabitants. Therefore, studying livelihood infrastructure, particularly examining the impact and mechanisms of the transformation of drinking water on income inequality among farmhouseholds, holds significant practical significance for consolidating the achievements of poverty alleviation.

Despite water supply being one of the most fundamental infrastructures for people's livelihoods, its impact on income inequality among rural households has rarely been explored in depth in existing literature from this perspective. This paper strives to bridge the research gap by exploring the impact of water supply infrastructure on income inequality among rural households, thereby offering a scientific foundation for related policy formulation. Utilizing panel data from the CFPS spanning from 2010 to 2018, this study investigates the effects and underlying mechanisms of drinking water transformation, as a critical aspect of livelihood infrastructure, on reducing income disparities among agricultural households. The potential marginal contributions of this paper are as follows: Firstly, based on the new development stage of agricultural and rural modernization, this paper introduces the Kakwani relative deprivation index to measure relative income inequality among rural households, more accurately reflecting the micro-characteristics of income inequality behind income differentiation. Secondly, considering the transformation of drinking water as a quasi-natural experiment, this study utilizes a progressive DID model to assess the effect of drinking water transformation on income inequality among farmhouseholds. Moreover, robustness tests such as parallel trends tests, and placebo tests are conducted to address selection biases, providing more robust and reliable research conclusions. Based on these analyses, the focus is placed on the role of drinking water transformation in enhancing household health capital and psychological capital, exploring the pathways through which livelihood infrastructure construction influences income inequality among farmhouseholds. This helps to further clarify the transmission mechanisms of livelihood infrastructure's impact on income inequality among farmhouseholds. Finally, through conducting a threshold effect test, it was discovered that as household per capita net income increases, the influence of drinking water transformation on income inequality among rural households demonstrates an inverted U-shaped nonlinear pattern, initially rising and then decreasing. By elucidating the effects and mechanisms of drinking water transformation on income disparities among rural households, this study offers fresh empirical evidence to support the advancement of livelihood infrastructure enhancements aimed at minimizing income inequality in rural areas. It also offers policy suggestions for the government to continuously carry out rural livelihood infrastructure construction to promote poverty reduction and income increases for farmers.

Theoretical Analysis and Research Hypothesis

Building upon the endogenous growth theory proposed by Change (1990) [17], Barro (1990) introduced infrastructure stock as a determinant of total factor productivity in the production function and constructed a public goods model [18]. The study found that infrastructure stock directly promotes economic growth through capital accumulation and indirectly enhances wealth accumulation by improving social total factor productivity. In terms of rural infrastructure construction, the government's strong guidance and demonstration effect through infrastructure investment influence the flow of stock and flow industry funds, thereby affecting output structure [19]. When the government increases the supply of rural public goods, it can guide the optimization and adjustment of the rural production and living structure, fundamentally promoting increased income for farmers and ensuring sustainable income growth. In research on sustainable and equitable supply of livelihood infrastructure, an increasing number of scholars have advocated policies that prioritize safe water supply to rural areas. Rural regions face the dilemma of market failure, and public services can effectively address this predicament. Recent studies have found that participatory community development reduces consumption poverty, and policies such as "whole-village promotion" in water improvement promote equalization of urban-rural environmental sanitation services. When measuring multidimensional poverty, the use of the generalized growth incidence curve reveals the pro-poor nature of multidimensional poverty reduction. It was found that in the context of water improvement, low-income farmhouseholds experienced greater growth, with the growth rate of tap water usage for the lowest-income group exceeding the average growth rate of tap water usage overall, indicating that water improvement contributes to poverty reduction [20]. In conclusion, rural infrastructure construction in China, particularly water improvement, can promote income growth among farmhouseholds and reduce income inequality. Based on this, the first research hypothesis is proposed:

H1: Rural livelihood infrastructure can reduce income inequality among farmhouseholds.

From the perspective of household health capital, promoting rural livelihood infrastructure construction can improve the per capita environment, enhance overall family health levels, and thereby reduce income inequality among farmhouseholds. This is because, on one hand, rural livelihood infrastructure can effectively improve the health levels of rural residents. Studies have found a close correlation between regional public health infrastructure and the occurrence of chronic diseases [21], and different levels of regional public health infrastructure significantly impact health inequality [22]. Additionally, the construction of safe drinking water, sanitation facilities, and other related infrastructure can effectively improve the health conditions of farmhouseholds, with more significant effects for impoverished families [23]. On the other hand, enhancing health levels can significantly decrease income disparities among agricultural households. As health is a core human capital variable that influences household income [24], health issues primarily manifest in the impairment of income and earning capacity. This includes reduced labor time and increased medical expenses due to illness, which lower household income levels and push them into poverty. Impoverished individuals or regions often lack sufficient coverage of health insurance, resulting in greater income and expenditure fluctuations when faced with health problems, exacerbating the vulnerability of poverty [25], and further contributing to income inequality. Based on this, the second hypothesis is proposed:

H2: Rural livelihood infrastructure can reduce income inequality among farmhouseholds by improving health capital.

From the perspective of residents' psychological capital, rural livelihood infrastructure construction can enhance residents' confidence in life, thereby improving their psychological capital and promoting the reduction of income inequality among farmhouseholds. Positive psychology suggests that psychological capital is reflected in psychological states and abilities such as confidence accumulation, optimistic attitudes, and resilience [26]. On the one hand, rural livelihood infrastructure can effectively enhance residents' psychological capital. The improvement of rural livelihood infrastructure leads to increased investment in inclusive public services, which significantly affects residents' life satisfaction, self-confidence, and other aspects of psychological capital. This has been verified by numerous studies [27]. Additionally, the improvement of infrastructure provides a basic guarantee for villagers' normal production and living, ensuring their production and livelihoods, creating a more livable environment, and facilitating faster and more convenient social development. These factors provide strong support for residents in building psychological capital. On the other hand, the enhancement of psychological capital can effectively reduce income inequality among farmhouseholds. Existing research has found that self-efficacy is a key predictor of improving poverty conditions. Higher levels of self-confidence enable individuals to set higher goals, exert more effort, and persevere for longer periods [28]. If the self-confidence of impoverished farmers is boosted, it can activate their internal motivation and empower them to rely on their hard work and intelligence to lift themselves out of poverty, thereby advancing poverty alleviation efforts. Based on this, the third hypothesis is proposed:

H3: Rural livelihood infrastructure can reduce income inequality among farmhouseholds by increasing psychological capital.

Experimental Procedures

Model Specification

The "progressive" DID model effectively evaluates policy impacts, capturing dynamic changes before and after policy implementation while allowing for a certain lag in policy effects. Additionally, it controls for potential confounding variables, enhancing the accuracy of estimates. Of course, the "progressive" DID model relies heavily on the accurate identification of policy timing and the assumption of a balanced trend for its validity. Hence, this study utilizes a "progressive" DID model to devise a quasi-natural experiment and assess the effect of drinking water transformation on income disparities among agricultural households. The specification of the model is as follows:

$$\mathrm{Y_{i,t}} = \alpha_0 + \alpha_1 \mathrm{TreatPost_{i,t}} + \alpha_c \mathrm{Z_{i,t}} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

In Equation (1), i represents cities, t represents time years, $Y_{i,t}$ represents the dependent variable, which is the income inequality of farmhousehold i in year t. $TreatPost_{i,t}$ represents the drinking water transformation, serving as a proxy variable for livelihood infrastructure, with its α_1 coefficient reflecting the effect of the drinking water transformation. $Z_{i,t}$ represents a series of control variables, including farmhousehold and household head characteristics, and so on. μ_t represents village-level fixed effects. δ_t represents time fixed effects. $\varepsilon_{i,t}$ represents the error term, capturing unobserved factors in the model.

To conduct policy evaluation using the DID approach, it is essential to satisfy the parallel trends assumption, which implies that before the implementation of the pilot policy, the income inequality of households using tap water and households not using tap water follows the same trend. Additionally, factors such as the intensity of the government's livelihood infrastructure construction policy, the implementation basis, and household economic characteristics can influence the drinking water transformation, potentially leading to lagged and absorbed effects of the policy implementation. To incorporate these considerations, this study utilizes the methodology introduced by Beck et al. (2010) and applies an event analysis technique to formulate the subsequent dynamic model [29]:

$$Y_{i,t} = \beta_0 + \sum_{t=-3}^{t=3} \beta_t treat_i \times time_t + \theta_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{2}$$

In Equation (2), i represents cities, and t represents years. $treat_i \times time_t$ represents a set of dummy variables for the three policy periods before and after the drinking water transformation, β_t which is the estimated coefficient of primary interest in this study. The other variables remain unchanged from the baseline model. If the regression coefficient fails to achieve statistical significance, it indicates the absence of a substantial difference in income inequality between the experimental and control groups of rural households before the drinking water improvement. If the regression coefficient successfully undergoes the significance test, it signifies that, as determined through parallel trends analysis, a substantial disparity in income inequality exists between the experimental and control groups of agricultural households subsequent to the drinking water renovation.

Furthermore, to further examine whether drinking water transformation can reduce income inequality among farmhouseholds by improving health capital and psychological capital, mediation analysis is conducted using the following mediation model:

$$M_{i,t} = \beta_0 + \beta_1 TreatPost_{i,t} + \beta Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{3}$$

$$Y_{i,t} = \beta_0 + \beta_1 TreatPost_{i,t} + \beta_2 M_{i,t} + \beta Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{4}$$

These mediation models enable us to investigate the intermediary function of health capital and psychological capital in the association between drinking water renovation and income disparities among agricultural households.

For varying levels of per capita net income among agricultural households, the influence of drinking water renovation on income disparities may demonstrate a nonlinear effect. Hence, we formulate the following panel threshold model:

$$Y_{i,t} = \gamma_0 + \gamma_1 X_{i,t} \times I(H_{i,t} \le \theta) + \gamma_1 X_{i,t} \times I\,(H_{i,t} > \theta) + \gamma_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{5}$$

In Equation (5), $H_{i,t}$ represents the threshold variable, $I(\cdot)$ which is an indicator function taking a value of 1 or 0 depending on whether the condition in parentheses is satisfied or not. Equation (5) represents a single threshold model, and in practice, it can be extended to multiple threshold scenarios based on the empirical results of statistical tests.

Variable Selection

The data is sourced from the CFPS survey administered by the Institute of Social Science Survey, Peking University. CFPS is a nationwide, comprehensive social tracking survey program whose samples encompass representative cases from various parts of the country, providing a comprehensive reflection of the actual situation in Chinese society. Rigorous sampling methods are employed in CFPS to ensure sample diversity and representativeness. As a biennial longitudinal survey, CFPS offers representative data over time. Through continuous tracking surveys, it captures the dynamic processes of social change, reflecting China's economic development and social transformation. This paper utilizes panel data from five consecutive periods between 2010 and 2018, encompassing 16,000 households from 25 provinces, cities, and autonomous regions in mainland China, with the exclusion of Tibet, Qinghai, Ningxia, Xinjiang, and Inner Mongolia. The survey encompasses variables such as family demography and economics, and includes detailed inquiries about household water usage, providing robust data support for this study.

Dependent Variable

In this study, the dependent variable is represented by the Kakwani Relative Deprivation Index, a measure that reflects income inequality at the county level. In the county context, income levels are easily comparable and perceived by households. According to the theory of relative deprivation, households with higher income levels are relatively less deprived and face fewer income disadvantages, resulting in lower levels of income inequality [4]. Hence, this study employs the Kakwani Relative Deprivation Index as a metric to assess this phenomenon. Specifically, the study selects other households within the same village as the reference group and compares the income of each household with the incomes of other higher-income households in the reference group to derive their relative deprivation index. The specific calculation method is as follows:

$$Kakwani = \frac{1}{n\mu_X}\sum_{j=1}^{n}(x_j - x_i) = \lambda_{x_i}^{+}\frac{\mu_{x_i}^{+} - x_i}{\mu_X} \tag{6}$$

In Equation (6), x_i represents the average net income of the i household in the sample group sorted by income in ascending order; X represents the selected reference group; μ_X represents the mean income of all households in X; $\mu^+_{x_i}$ represents the mean income of the sample households whose income exceeds x_j; $\lambda^+_{x_i}$ represents the percentage of sample households whose income exceeds out of the total sample size. The relative deprivation index yields values ranging from 0 to 1, where higher coefficient values signify greater degrees of income disparity among households.

Drinking Water Transition Variable

The water transformation variable serves as a crucial explanatory factor in this investigation, aligning with an inquiry posed in the CFPS questionnaire: "Which type of water do you primarily use for cooking? If you use two or more types of water, please select the one you use most frequently for cooking." It is defined as a binary variable. Specifically, tap water = 1 represents households that choose tap water, while tap water = 0 represents households that choose other sources of water, such as river or lake water, well water, rainwater, cellar water, water from ponds or springs, and bottled, purified, or filtered water, among others.

Mediating Variable

To test hypotheses H2 and H3, this study includes mediator variables to explore the mechanisms through which water transformation affects household income inequality. For the purpose of analyzing causal mediation effects, the health status of the household head is selected as a surrogate variable to represent health capital. As for the proxy variable representing psychological capital, the self-confidence of the household head is selected.

Control Variable

Based on the existing research by domestic and international scholars on the factors influencing household income inequality, this study also controls for household characteristics and household head individual characteristics. The control variables for household characteristics include the natural logarithm of household net assets, whether the household has land distribution, household size, the number of household laborers, dependency ratio, and whether the household owns property. The control variables for household head individual characteristics include gender, age, marital status, employment status, years of education, party membership, and cognitive ability.

Descriptive Statistics

The data utilized in this study comprises questionnaires for households, adults, and children from the CFPS database spanning the 2010-2018 period. After eliminating samples with missing crucial variable data, we obtained a total of 12,380 observations. Table 1 outlines the variable descriptions and descriptive statistics. As evident from Table 1, the mean value of household income inequality stands at 0.446, suggesting a relatively balanced overall income distribution. Additionally, the mean value for water transformation is 0.52, implying that 52.4% of the sampled households use tap water. In terms of individual and household characteristics within the sample, the average natural logarithm of household net assets is 11.708. Notably, 96% of the households possess property, and 92% hold collective land. The mean number of workers per household is 3.056, with an average dependency ratio of 15%.

Among the interviewed heads of households, 63% are male, with a mean age of 50.08 years. Furthermore, 72.9% of the heads are married, 7.1% are party members, and their average education level is 2.9, equivalent to a high school graduation on average. The mean cognitive ability score for household heads is 5.11, and 45.1% are engaged in non-agricultural occupations.

Results and Discussion

Baseline Regression

Water transformation can reflect the situation of rural livelihood infrastructure development to some extent. Livelihood infrastructure development has significant effects on local economic growth, livelihood improvement, and farmers' income, thereby influencing income inequality among households. This study employs the two-way fixed effects "progressive" Difference-in-Differences (DID) approach to assess the impact of water transformation policies on household income inequality. Regression analysis is performed by gradually adding control variables to examine the effect of livelihood infrastructure on reducing income inequality. Specifically, Table 2 presents the panel random effects regression results of water transformation on income inequality in column (1); and the regression results of water transformation on income inequality without controlling for other variables in column (2). Based on the observations, the estimated coefficient for water transformation significantly stands out as positive, reaching the 1% significance level. Columns (3) to (5) show the regression results after gradually adding household features, head of household characteristics, and controlling for village and county fixed effects. Throughout the analysis, it is observed that the estimated coefficient for water transformation maintains its significance at the 5% level, consistently exhibiting a negative sign. The introduction of control variables neither alters the sign nor affects the significance of the coefficient. Hence, this suggests that water transformation serves to mitigate income inequality among households, thereby validating hypothesis H1.

Table 1. Variable Description and Summary Statistics.

Variable Name		Survey Question	Mean	Standard Deviation
Dependent Variable	Income Inequality	Relative deprivation index of per capita household income	0.448	0.260
Explanatory Variable	Water Transformation	Whether the household uses tap water for cooking (1 if yes, 0 if no)	0.518	0.500
Mediating Variables	Health Capital	Average health level of adult household members	3.205	0.997
	Psychological Capital	Average level of self-confidence among adult household members	3.921	0.823
Household Features	Household Net Assets	Natural logarithm of household net assets	11.708	1.155
	Ownership of Housing	Who owns the current residence (1 if owned, 0 if not)	0.964	0.185
	Distribution of Collective Land	Which collective land the household has obtained (1 if yes, 0 if no)	0.924	0.266
	Number of Laborers	Number of adult household members	3.056	1.297
	Dependency Ratio	Proportion of underage household members to the total household size	0.150	0.171
Head of Household Characteristics	Gender of Head of Household	Gender of the head of the household (1 if male, 0 if female)	0.635	0.482
	Age of Head of Household	Age of the head of the household	50.084	11.495
	Marital Status of Head of Household	Current marital status of the head of the household (1 if married, 0 if single)	0.729	0.444
	Party Membership of Head of Household	Whether the head of the household is a party member (1 if yes, 0 if no)	0.071	0.256
	Education Level of Head of Household	Highest educational attainment of the head of the household	2.916	1.733
	Cognitive Ability of Head of Household	Cognitive ability score of the head of the household	5.112	1.261
	Non-agricultural Employment of Head of Household	Main nature of the current job of the head of the household (1 if non-agricultural, 0 if agricultural)	0.451	0.498

Robustness Tests

Although the baseline regression results show that water transformation can reduce income inequality among households, there may still be potential interference from omitted variables, sample selection bias, and other factors. To further bolster the credibility of the empirical findings, this study performs robustness tests encompassing multiple aspects such as parallel trend analysis, placebo tests, alternative dependent variables, and PSM-DID estimation.

Balance Tests

The reduction in income inequality among households as a result of water transformation may be a long-term process. To validate the possibility of long-term reduction in income inequality through water transformation, this study employs an event analysis approach and decomposes the effect of water transformation into different years to observe its dynamic changes. Specifically, to test the parallel trends assumption in the DID model, this study uses graphical comparisons to examine the trend of income inequality before and after water transformation and presents the chart of the coefficient and its 95% confidence interval as described in Equation (2). Based on Fig. 1, it is evident that the disparity in income inequality between the treatment and control groups was narrower before the implementation of water transformation as compared to the post-policy implementation difference. Hence, the DID method proves suitable for assessing the influence of water transformation on household income inequality, and this conclusion's validity is reinforced through parallel trends analysis.

The findings reveal that the impact of water transformation on household income inequality demonstrates a noticeable lag, with the policy effect displaying dynamic variations over time. This suggests that improvements in livelihood infrastructure

Table 2. Baseline Regression Results.

Variables	(1)	(2)	(3)	(4)	(5)
Water Transformation	-0.020***	-0.022***	-0.017**	-0.014**	-0.013**
	(-3.62)	(-2.94)	(-2.47)	(-2.04)	(-2.04)
Household Net Assets	-0.076***		-0.078***	-0.071***	-0.071***
	(-26.47)		(-22.97)	(-21.94)	(-21.94)
Owns Housing	0.081***		0.096***	0.079***	0.079***
	(5.56)		(6.46)	(5.54)	(5.53)
Obtains Land	0.046***		0.058***	0.046***	0.046***
	(4.35)		(5.11)	(4.21)	(4.22)
Labor Force	-0.002		-0.003	-0.001	-0.001
	(-0.72)		(-1.24)	(-0.66)	(-0.66)
Dependency Ratio	0.228***		0.201***	0.247***	0.247***
	(14.61)		(12.27)	(15.38)	(15.38)
Head of Household Gender	0.001			0.008	0.008
	(0.19)			(1.42)	(1.42)
Head of Household Age	0.002***			0.002***	0.002***
	(7.10)			(7.61)	(7.61)
Marital Status of Head of Household	0.051***			-0.004	-0.004
	(7.73)			(-0.33)	(-0.35)
Party Membership of Head of Household	-0.032***			-0.023**	-0.023**
	(-2.92)			(-2.27)	(-2.22)
Education Level of Head of Household	0.002			-0.016***	-0.017***
	(0.97)			(-6.83)	(-6.89)
Intelligence Level of Head of Household	-0.009***			-0.008***	-0.008***
	(-4.88)			(-3.75)	(-3.76)
Non-agricultural Employment of Head of Household	0.027***			0.034***	0.034***
	(4.64)			(5.25)	(5.26)
Constant Term	1.098***	0.459***	1.199***	1.105***	1.106***
	(27.65)	(94.79)	(29.17)	(25.45)	(25.46)
Controls for Time	NO	YES	YES	YES	YES
Controls for Village	NO	YES	YES	YES	YES
Controls for County	NO	NO	NO	NO	YES
N	12,380	12,340	12,340	12,340	12,340
R-squared	0.1484	0.1839	0.2756	0.2944	0.2946

Note: Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively. The table presents the regression results for different models/columns. The coefficients, t-statistics (in parentheses), and statistical significance levels are reported for each variable in the regression models. The table also indicates the inclusion of control variables and provides information on the number of observations (N) and the R-squared value for each model/column.

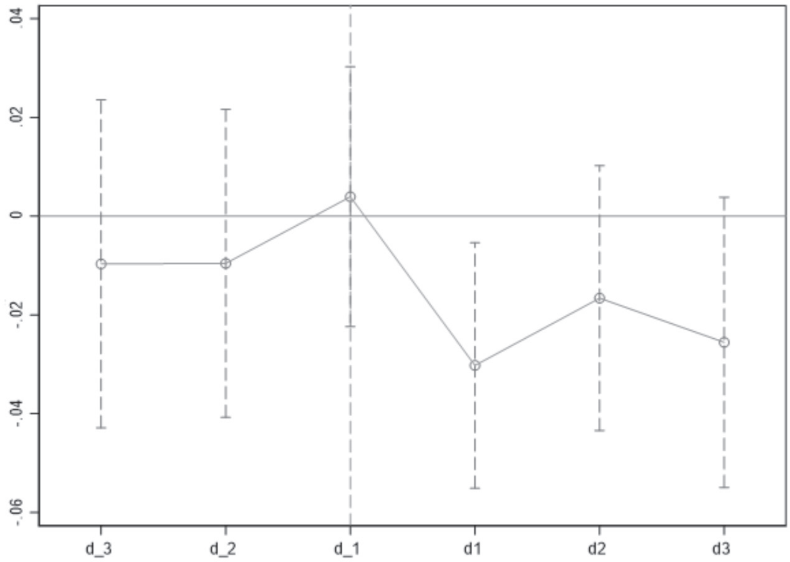

Fig. 1. Balance Trend Test Results

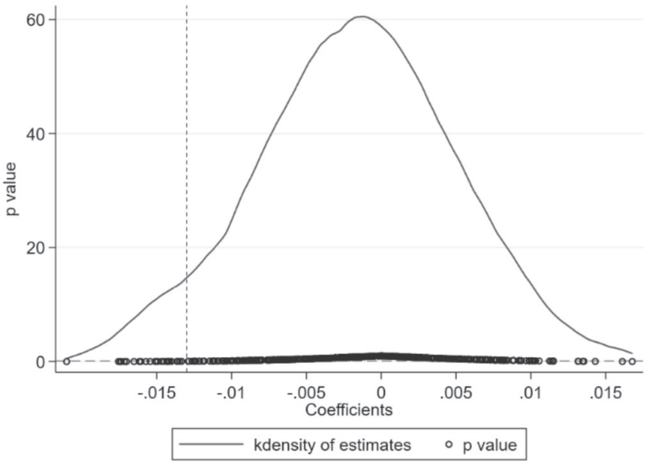

Fig. 2. Placebo Test Results.

can consistently reduce income inequality among households. Thus, water transformation has the potential for a long-term reduction in income inequality and sustainable development.

Placebo Test

While the balance trend test results suggest that the research methodology in this study adheres to the assumptions of the multi-period DID model, there is still a theoretical possibility of omitted variable bias that could potentially affect the robustness of the empirical results. To alleviate this concern, a placebo test utilizing random assignment was performed to substantiate the influence of drinking water transformation on household income inequality. Specifically, while ensuring the unchanged distribution of data, a subset of households (the treatment group) was randomly selected from a sample of 2,476 households, while the remaining households (the control group) were treated as the control group. The virtual data were then reanalyzed to examine whether the poverty reduction effect was induced by the drinking water transformation. If, under this condition, the estimated coefficient of drinking water transformation remains statistically significant, it suggests that the empirical results of this study may be influenced by unobserved factors. Alternatively, if the estimated coefficient lacks statistical significance, it signifies a legitimate poverty-reducing impact attributed to drinking water transformation. The sample underwent 500 random selections, and subsequent regression analyses adhered to the specifications outlined in Column (5) of Table 2. Fig. 2 illustrates the density distribution of t-values pertaining to drinking water transformation derived from these 500 random samples. It can be observed that the t-statistics of drinking water transformation are predominantly centered around zero, with only a few estimates surpassing the benchmark regression. The results indicate that in these 500 random samples, most of the policy variables' estimated effects did not pass the significance test, suggesting that unobserved random factors do not affect the model estimates. Therefore, the placebo test confirms that the empirical results of this study genuinely reflect the poverty reduction effect of drinking water transformation on reducing household income inequality.

Other Robustness Tests

(1) Substitution with Continuous Variable: Considering the variations in the use of drinking water transformation among different households, this study employs the logarithm of the monthly water bill as a proxy variable to measure the achievements of community infrastructure development. This provides evidence from the estimation results using a continuous variable. Since the monthly water bill is an important indicator of community infrastructure usage and is consistent with the objectives of drinking water transformation, to ensure the accuracy of the conclusions, this study further substitutes the continuous variable of the logarithm of the monthly water bill for the dummy variable of drinking water transformation and conducts robustness tests. Table 3, Column (1), presents the regression estimation results for the relationship between the logarithm of the monthly water bill and household income inequality. By substituting a continuous variable, the regression analysis reveals a significantly negative coefficient ($p<0.05$) for the logarithm of the monthly water bill, reinforcing the notable impact of drinking water transformation in reducing household income inequality.

(2) PSM-DID: The household selection for drinking water transformation does not strictly meet the assumption of random selection, thus potential sample selection bias may exist. To mitigate concerns regarding sample self-selection bias, this study utilizes the PSM-DID methodology for robustness testing. Specifically, we employ control variables as covariates to compute propensity scores via logistic regression, followed by sample matching. In this study, we utilize nearest neighbor matching, caliper matching, and kernel matching techniques to achieve optimal sample pairing, thereby eliminating disparities between the treatment and control groups. This approach enhances sample comparability, effectively addressing the issue of sample self-selection. Subsequently, regression estimation is conducted using the newly matched samples, and the outcomes are documented in Columns (2)-(4) of Table 3. The findings reveal that, within the newly selected samples, the coefficients of the drinking water transformation dummy variable maintain a negative value and exhibit statistical significance at the 5% level, further corroborating the study's robust results.

Mediation Effects

Drawing from the preceding analysis, the introduction of drinking water transformation among rural households has the potential to reduce income inequality through the enhancement of health capital and psychological capital. To substantiate this mechanism, a mediation effects model is employed in this study, with

Table 3. Robustness Test Results.

Variables	(1)	(2)	(3)	(4)
	Substitution with Continuous Variable	PSM-DID		
		k-Nearest Neighbor Matching(k=5)	Caliper Matching Kernel	Matching
Logarithm of Monthly Water Bill	-0.006**			
	(-2.18)			
Drinking Water Transformation		-0.013**	-0.013**	-0.013**
		(-2.01)	(-2.01)	(-2.01)
Constant	1.034***	1.122***	1.126***	1.127***
	(19.29)	(27.04)	(26.95)	(26.99)
Control Variables	YES	YES	YES	YES
Control for Time	YES	YES	YES	YES
Control for Village	YES	YES	YES	YES
Control for County	YES	YES	YES	YES
N	7398	12337	12333	12334
R-squared	0.2866	0.2969	0.2966	0.2968

detailed estimation results outlined in Table 4. Initially, as indicated in column (1) of the estimation results, it is apparent that drinking water transformation exhibits a significantly negative influence on income inequality among rural households. This indicates that drinking water transformation effectively reduces income inequality among rural households. Simultaneously, based on the estimation results in column (2), the effect of drinking water transformation on household health capital is significantly positive, implying that drinking water transformation promotes the improvement of average health levels within households. By simultaneously including drinking water transformation and household health capital in the regression model, as shown in column (3), it can be observed that both drinking water transformation and household health capital have significant negative effects on income inequality in rural households. Furthermore, the estimated coefficient of drinking water transformation decreases noticeably compared to the baseline regression coefficient. This suggests that drinking water transformation can reduce income inequality among rural households by improving household health capital. Moreover, the t-value of the policy variable estimation coefficient decreases, indicating the presence of partial mediation effects of household health capital, thus supporting Hypothesis 2. Next, according to the estimation results in column (4), it is found that drinking water transformation has a significant positive effect on household psychological capital, indicating that it enhances the confidence of household members. When both drinking water transformation and household psychological capital are included in the regression model, as shown in column (5), it is observed that both variables have significant negative effects on income inequality in rural households. Additionally, the estimated coefficient of the policy variable shows a noticeable decrease compared to the baseline regression coefficient. This suggests that drinking water transformation can reduce income inequality among rural households by enhancing household psychological capital. Moreover, the t-value of the drinking water transformation estimation coefficient decreases, indicating the presence of partial mediation effects of household psychological capital, thus supporting Hypothesis 3.

Further Analysis

Threshold Effects

The baseline regression results indicate that drinking water transformation promotes a reduction in income inequality among households. However, as there are differences in per capita net income among different households, the impact of drinking water transformation on income inequality may vary. In order to uncover the potential nonlinear effects of drinking water transformation on income inequality, this section conducts threshold regression analysis using per capita net income as the threshold variable. First, we set one, two, and three thresholds and use a "bootstrapping" method to repeatedly sample 500 times. The obtained threshold numbers, P-values, and

Table 4. Mechanism Test Results.

Variables	(1)	(2)	(3)	(4)	(5)
	Income Inequality	Health Capital	Income Inequality	Psychological Capital	Income Inequality
Drinking Water Transition	-0.013**	0.060**	-0.011*	0.040*	-0.013*
	(-2.04)	(2.53)	(-1.73)	(1.81)	(-1.93)
Health Capital			-0.037***		
			(-12.10)		
Psychological Capital					-0.020***
					(-6.40)
Constant	1.106***	2.142***	1.184***	2.955***	1.163***
	(25.46)	(14.57)	(27.95)	(22.46)	(26.25)
Control Variables	YES	YES	YES	YES	YES
Control Time	YES	YES	YES	YES	YES
Control Village	YES	YES	YES	YES	YES
Control District	YES	YES	YES	YES	YES
N	12340	12340	12340	12340	12340
R-squared	0.2946	0.3852	0.3069	0.2213	0.2976

Table 5. The results of the threshold effects analysis.

Threshold	RSS	MSE	Fstat	Prob	Crit10	Crit5	Crit1
Single	333.26	0.03	3071.52	0.00	10.27	12.11	15.36
Double	309.17	0.03	964.27	0.00	12.11	14.17	18.64
Triple	300.52	0.02	356.00	0.42	407.83	424.93	456.01

F-statistics are presented in Table 5. Table 5 reveals that the F-statistic for the first threshold characteristic of the digital economic development level stands at 3100.56, surpassing the critical value of 16.0799 and thus passing the significance test at the 1% level. Similarly, the second threshold feature's F-statistic is 994.22, exceeding the critical value of 19.2409 and also passing the significance test at the 1% level. However, the F-statistic for the third threshold feature, at 355.14, falls below the critical value of 402.1538, failing to meet the significance test even at the 10% level. In conclusion, this study utilizes a double-threshold model to investigate the threshold effects of per capita net income on the influence of drinking water transformation on household income inequality. With per capita net income as the threshold variable, Table 6 displays the outcomes of the double-threshold regression estimates from the threshold effects analysis on the impact of drinking water transformation on household income inequality.

In Table 6, column (1) shows that when the per capita net income level of households is below 4333, the effect of drinking water transformation is significantly negative, indicating that for households with lower per capita net income, drinking water transformation exacerbates income inequality. Column (2) of Table 6 shows that when the per capita net income is in the interval above 4333, this effect starts to become significantly negative. Furthermore, when the per capita net income is in the interval (4333, 12500), the impact of drinking water transformation becomes significant with a coefficient of -0.026, indicating the influence of drinking water transformation on income inequality at a certain level of per capita net income. However, column (3) of Table 6 shows that when the per capita net income exceeds $12500, the coefficient of drinking water transformation decreases significantly to -0.218. Overall, the impact of drinking water transformation on income inequality among households exhibits a non-linear pattern. As the per capita net income of households increases, the effect of drinking water transformation on income inequality follows an inverted U-shaped curve, initially increasing and then decreasing.

Heterogeneity Analysis

During the phase of accelerated industrialization and urbanization, it is inevitable for the agricultural land of households to be converted into non-agricultural land. Therefore, when households lose their land, they become a marginalized group that is distinct from both land-owning households and urban households. In this context, studying the differential effects of drinking water transformation on income inequality for different samples of households, based on whether they own land, holds special significance. To analyze in detail the impact of drinking water transformation on income inequality for households with and without land, this section divides the sample into land-owning

Table 6. The results of the threshold effects.

Variable	(1)	(2)	(3)
Per Capita Net Income Range	(0,4333]	(4333,12500]	(12500,∞)
Drinking Water Transformation	0.228^{***}	-0.026^{***}	-0.217^{***}
	(33.54)	(-4.42)	(-32.26)
Constant	0.642^{***}		
	(20.78)		
Control Variables	YES		
Control Time	YES		
Control Village	YES		
Control County	YES		
N	12380		
R-squared	0.304		

households and landless households. Columns (1) and (2) of Table 7 respectively present the impact of drinking water transformation on income inequality among households that own land and those that do not. The study results indicate that drinking water transformation significantly affects income inequality among land-owning households, whereas it has no such impact on landless households. A plausible explanation could be that as industrialization and urbanization progress, land-owning farming households are located far from urban areas, and the utility of drinking water transformation is greater for such households. Therefore, in the subsequent consolidation of poverty alleviation efforts and the realization of rural agricultural modernization, policy measures should be strengthened specifically for landless households to better promote rural development and achieve shared prosperity. The division of labor and specialization among farmers is a trend in modern agricultural development, enabling households to transition from being solely agricultural producers and operators to producers and operators in non-agricultural industries. Hence, the allocation of tasks and specialization within the farming community has a substantial effect on income disparities among households. As such, exploring the ramifications of drinking water transformation on income inequality among sampled households, contingent upon whether the head of the household is involved in non-agricultural pursuits, holds significant importance. To analyze in detail the effects of drinking water transformation on income inequality for different sample households based on whether the household head engages in non-agricultural work, this section further divides the sample into households with non-agricultural employment by the household head and households with agricultural employment by the household head. Columns (3) and (4) of Table 7 exhibit the consequences of drinking water transformation on income inequality for households where the head of the household is engaged in non-agricultural and agricultural occupations, respectively. The findings indicate that drinking water transformation notably affects income inequality among households whose heads are employed in agriculture, whereas it does not significantly influence households where the head is employed in non-agricultural sectors. This suggests that drinking water transformation has greater utility for households engaged in agricultural work.

Discussion

Infrastructure related to livelihood serves as a pivotal material base for rural economic advancement. As China's rural economy has experienced swift growth, scholars have increasingly focused on the correlation between enhancing livelihood infrastructure and the income disparities among rural households. While prior investigations have delved into the role of infrastructure development in bridging the income divide, comprehensive analyses on the effect of livelihood infrastructure, specifically the transformation of drinking water systems, on income inequality remain scarce. This study strives to address this research void through a more exhaustive and profound analytical approach.

The findings from this study reveal that the transition to drinking water for rural households has positively impacted the enhancement of rural residents' quality of life and the refinement of household economic structures, thereby effectively mitigating income disparities among rural households. This is confirmed by panel data analysis from the CFPS from 2010 to 2018. Internally, the transition to drinking water has improved the health conditions and psychological states of rural households, thereby increasing labor productivity and economic well-

Table 7. The results of the heterogeneity analysis.

Variable	(1)	(2)	(3)	(4)
	Land-owning Households	Landless Households	Households with Non-Agricultural Employment by Household Head	Households with Agricultural Employment by Household Head
Drinking Water Transformation	-0.012*	-0.030	-0.001	-0.023**
	(-1.74)	(-1.02)	(-0.14)	(-2.48)
Constant	1.210***	0.739***	1.239***	1.062***
	(26.38)	(5.45)	(20.44)	(17.98)
Control Variables	YES	YES	YES	YES
Control Time	YES	YES	YES	YES
Control Village	YES	YES	YES	YES
Control County	YES	YES	YES	YES
N	11388	818	5506	6755
R-squared	0.296	0.450	0.300	0.343

being and reducing economic losses caused by health issues. Additionally, the transition of drinking water interacts synergistically with household characteristics such as land ownership and the employment type of the head of the household, enhancing its effect on reducing income inequality. These findings align with existing literature on infrastructure improvement and social welfare enhancement. However, this paper provides a more detailed analysis by introducing the perspective of the drinking water transition.

Despite providing new insights into the field of livelihood infrastructure and income inequality among rural households both theoretically and empirically, this study has certain limitations. For instance, the analysis primarily focuses on the Chinese context and may not be applicable in other countries or regions. Future studies could delve deeper into examining the correlation between advancements in livelihood infrastructure and income disparities across various national and regional backgrounds. Additionally, identifying efficient methods to advance livelihood infrastructure worldwide has the potential to nurture balanced socio-economic progress in rural settings. By presenting the aforementioned discussion, this paper establishes an empirical foundation for comprehending the influence of livelihood infrastructure on income inequality among rural households while also presenting invaluable perspectives for relevant policy formulation and scholarly investigations.

Conclusions

The construction of livelihood infrastructure has profound practical significance for consolidating and expanding the achievements of poverty alleviation and realizing the modernization of rural agriculture. Among these infrastructure projects, the provision of drinking water to rural households is a people-centered and growth-stabilizing project that benefits the well-being of the population. Therefore, studying the effects of rural household water transformation on improving income inequality and consolidating poverty reduction outcomes is of great practical importance. In the backdrop of rural agricultural modernization, our study relies on data from the CFPS spanning from 2010 to 2018. We adopt the deprivation index as a metric for income disparity and employ a "progressive" DID model to empirically investigate the effect of water transformation among rural households on income inequality. Our results indicate that water transformation among rural households notably diminishes income inequality, primarily by bolstering household health and psychological capital. This further clarifies the transmission mechanism through which livelihood infrastructure affects income inequality among rural households. Furthermore, additional analysis reveals a non-linear "inverted U" relationship between the impact of water transformation on income inequality and per capita income. As per capita income increases, the influence of water transformation on income inequality first increases and then decreases. The effects of water transformation on income inequality are more pronounced for land-owning households and households with a predominant agricultural focus. This research provides new empirical evidence for advancing the improvement of income inequality through the development of livelihood infrastructure. It provides valuable insights for shaping pertinent policies aimed at reinforcing and extending the accomplishments of poverty alleviation efforts and the modernization process of rural agriculture.

Policy Recommendations

Drawing from the aforementioned research findings, we offer the following policy suggestions:

Firstly, the overall promotion of rural livelihood infrastructure construction should be prioritized. The government should formulate and implement specific plans to enhance rural drinking water safety, including upgrading existing water supply systems and constructing new water supply projects. These plans should consider water resource conditions, farmers' actual needs, and potential environmental impacts across different regions. Additionally, environmentally friendly and sustainable technologies should be adopted during the construction and operation of water supply projects to minimize damage to local ecosystems.

Secondly, differentiated farmer support policies should be implemented. Dynamic monitoring of drinking water conditions should be conducted in areas with weak water supply, poverty-stricken regions, and among vulnerable populations. Problems and risk factors in rural water supply should be accurately identified and recorded. Furthermore, it is essential to promote water supply to households, increase the penetration rate of rural tap water, and enhance water quality to ensure safe and healthy drinking water. Meanwhile, water source scheduling and optimal allocation should be strengthened to address instability issues and improve water source stability.

Thirdly, health education should be promoted, and residents' health awareness should be enhanced. The health risks associated with unhealthy drinking water practices should be clarified from the perspective of changing health conceptions. This will increase rural residents' subjective initiative to switch to tap water. Through community centers, schools, and media promotion, farmers' awareness of the importance of drinking water safety should be raised. Encouraging healthy lifestyles among villagers can reduce the disease burden caused by water source issues, indirectly improving households' economic well-being.

Fourthly, a long-term water supply management and maintenance mechanism should be established. To ensure the sustainability of the rural drinking water transition, a comprehensive water supply management and maintenance system needs to be established. Additionally, farmers and communities should be encouraged to participate in the management of water supply facilities, enhancing their sense of ownership and participation. Considering the uneven development among different regions, the government should formulate a regional coordinated development strategy, supporting livelihood infrastructure construction in economically backward areas through financial transfer payments and preferential policies.

Limitations and Further Research

This study provides new insights into the relationship between the transformation of drinking water sources for rural households and income inequality. However, there are still some limitations to this paper. Firstly, the dataset used in this study is limited to data from the CFPS from 2010 to 2018, which may not fully capture the differences in the development of livelihood infrastructure and income inequality across various countries and regions. Future research could expand to a broader international context to verify the universality and applicability of the conclusions of this study. Secondly, this paper lacks sufficient analysis of the mechanism by which the transformation of drinking water sources affects income inequality through indirect pathways such as improving employment and entrepreneurship opportunities and production efficiency. Future research could further explore these indirect impact mechanisms to provide a more comprehensive perspective. In addition, although this paper considers various control variables in the model setting, such as household and head-of-household characteristics, there may still be unobserved variables that could affect the accuracy of the model estimates. Future research could adopt more complex econometric models, such as structural equation models, to further control for potential omitted variable bias.

In light of the aforementioned limitations, future research can delve deeper into several directions. Firstly, conducting international comparative studies using similar empirical analyses across different countries and regions to explore whether there are differences in the correlation between livelihood infrastructure advancement and income inequality, as well as the economic, policy, and cultural factors behind these differences. Secondly, incorporating more multidimensional influencing factors as control variables, such as farmers' access to credit, market participation, and social networks, will help gain a more comprehensive understanding of the causes of income inequality. Further investigating the inherent mechanisms by which the transformation of drinking water affects income inequality and how these factors interact to jointly influence income inequality. Thirdly, examining the long-term dynamic effects of drinking water transformation on farmers' income inequality using long-term panel data and exploring how this effect evolves over time. Through in-depth research, we can more fully understand the complex relationship between the development of livelihood infrastructure and income inequality among rural households, providing more solid theoretical and empirical support for achieving rural poverty reduction and common prosperity goals.

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Conflict of Interest

The authors declare no conflict of interest.

References

1. ATKINSON A.B. On the measurement of inequality. Journal of Economic Theory. **2** (3), 244, **1970**.
2. SEN A.K. From income inequality to economic inequality. Southern Economic Journal. **64** (2), 384, **1997**.
3. CLARK A.E., FRIJTERS P., SHIELDS M.A. Relative income, happiness, and utility: an explanation for the easterlin paradox and other puzzles. Journal of Economic Literature. **46** (1), 95, **2008**.
4. XIE Y., ZHOU X. Income inequality in today's china. Proceedings of the National Academy of Sciences. **111** (19), 6928, **2014**.
5. KUZNETS S. Economic growth and income inequality. In The gap between rich and poor, Routledge: 25, **2019**.
6. ABATECHANIE M., CAI B., SHI F., HUANG Y. The environmental and socio-economic effect of farmland management right transfer in china: a systematic review. Land. **11** (8), 1333, **2022**.
7. OMAR M.A., INABA K. Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis. Journal of Economic Structures. **9** (1), 37, **2020**.
8. GAO J., LIU Y., CHEN J., CAI Y. Demystifying the geography of income inequality in rural china: a transitional framework. Journal of Rural Studies. **93**, 398, **2022**.
9. XIAO H., ZHENG X., XIE L. Promoting pro-poor growth through infrastructure investment: evidence from the targeted poverty alleviation program in china. China Economic Review. **71**, 101729, **2022**.
10. BENGTSSON E., MISSIAIA A., NUMMELA I., OLSSON M. Unequal poverty and equal industrialisation: finnish wealth, 1750-1900. Scandinavian Economic History Review. **67** (3), 229, **2019**.
11. HUO C., CHEN L. Research on the impact of land circulation on the income gap of rural households: evidence from chip. Land. **10** (8), 781, **2021**.

12. ZHANG Q., BILSBORROW R.E., SONG C., TAO S., HUANG Q. Rural household income distribution and inequality in china: effects of payments for ecosystem services policies and other factors. Ecological Economics. **160**, 114, **2019**.
13. LUO C., LI S., SICULAR T. The long-term evolution of national income inequality and rural poverty in china. China Economic Review. **62**, 101465, **2020**.
14. MISHRA A., AGARWAL A. Do infrastructure development and urbanisation lead to rural-urban income inequality? Evidence from some asian countries. International Journal of Sustainable Economy. **11** (2), 167, **2019**.
15. YU W., YAO Y. The route of development in intra-regional income equality via high-speed rail: evidence from china. **2019**.
16. ZHANG G., WU X., WANG K. Research on the impact and mechanism of internet use on the poverty vulnerability of farmers in china. Sustainability. **14** (9), 5216, **2022**.
17. CHANGE E.T. Endogenous technological change. Journal of Political Economy. **98** (5), 2, **1990**.
18. BARRO R.J. Government spending in a simple model of endogeneous growth. Journal of Political Economy. **98** (5), S103, **1990**.
19. ENGELMANN D., MUNRO A., VALENTE M. On the behavioural relevance of optional and mandatory impure public goods. Journal of Economic Psychology. **61**, 134, **2017**.
20. SUXIA W., XIANGHONG Z., XIAOLIN W., ZIRUI S. Poverty assessment in terms of safe drinking water, hygiene facilities, and energy of minority nationalities – a case study on the a ba autonomous prefecture of tibetan and qiang nationalities. Chinese Studies. **2** (01), 61, **2013**.
21. LI X., KRUMHOLZ H.M., YIP W., CHENG K.K., De MAESENEER J., MENG Q., MOSSIALOS E., LI C., LU J., SU M. Quality of primary health care in china: challenges and recommendations. The Lancet. **395** (10239), 1802, **2020**.
22. CREAR-PERRY J., CORREA-DE-ARAUJO R., LEWIS JOHNSON T., MCLEMORE M.R., NEILSON E., WALLACE M. Social and structural determinants of health inequities in maternal health. Journal of Women's Health. **30** (2), 230, **2021**.
23. ZHAO Y., ATUN R., OLDENBURG B., MCPAKE B., TANG S., MERCER S.W., COWLING T.E., SUM G., QIN V.M., LEE J.T. Physical multimorbidity, health service use, and catastrophic health expenditure by socioeconomic groups in china: an analysis of population-based panel data. The Lancet Global Health. **8** (6), e840, **2020**.
24. ZHOU Y., GUO Y., LIU Y. Health, income and poverty: evidence from china's rural household survey. International Journal for Equity in Health. **19**, 1, **2020**.
25. MA M., LI Y., WANG N., WU Q., SHAN L., JIAO M., FU X., LI H., SUN T., YI B. Does the medical insurance system really achieved the effect of poverty alleviation for the middle-aged and elderly people in china? Characteristics of vulnerable groups and failure links. Bmc Public Health. **20**, 1, **2020**.
26. LUTHANS F., LUTHANS K.W., LUTHANS B.C. Positive psychological capital: beyond human and social capital. **2004**.
27. FAHMI F.Z., SARI I.D. Rural transformation, digitalisation and subjective wellbeing: a case study from indonesia. Habitat International. **98**, 102150, **2020**.
28. WUEPPER D., LYBBERT T.J. Perceived self-efficacy, poverty, and economic development. Annual Review of Resource Economics. **9**, 383, **2017**.
29. BECK T., LEVINE R., LEVKOV A. Big bad banks? The winners and losers from bank deregulation in the united states. The Journal of Finance. **65**, (5), 1637, **2010**.