Impact of High Temperature on Rural Multidimensional Poverty: Evidence from Counties in Northern Jiangsu Province

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Abstract: Against the backdrop of intensifying global climate change and the in-depth implementation of the rural revitalization strategy, the contradiction between climate shocks and sustainable rural development has grown increasingly prominent. Taking counties in northern Jiangsu as the research sample and utilizing panel data from 2000 to 2023, this paper first constructs a county-level multidimensional poverty index (MPI) encompassing economic development, educational resources, and medical resources via the entropy method. From the three dimensions of agricultural production, labor supply, and living costs, it then empirically examines the transmission mechanisms through which high temperature affects county-level multidimensional poverty, using a two-way fixed effects model and a mediation effect model. The results indicate that high-temperature weather significantly aggravates multidimensional poverty in counties of northern Jiangsu. The impact is transmitted through three main channels: the core pathway is the suppression of agricultural output; additionally, high temperature reduces the effective labor supply in agriculture, forestry, animal husbandry and fishery, and drives up residential electricity costs for urban and rural residents, jointly amplifying the poverty effect. Accordingly, this paper proposes targeted strategies including industrial structure optimization, rural financial innovation, and infrastructure upgrading, providing practical references for northern Jiangsu to address climate risks and achieve sustainable rural revitalization.

Keywords: High Temperature, Multidimensional Poverty, Rural Revitalization, Counties in Northern Jiangsu.

1. Introduction

The 20th National Congress of the Communist Party of China made comprehensive arrangements for "comprehensively advancing rural revitalization", taking it as a major task for building a modern socialist country in all respects. The No. 1 Central Document of 2023 deployed "a new round of agricultural climate resource survey and zoning work" to provide scientific support for agriculture to adapt to climate change. The Central Economic Work Conference of 2024 emphasized "further promoting ecological civilization construction and green and low-carbon development", integrating rural low-carbon transformation into the overall strategy of carbon peaking and carbon neutrality. The 2025 No. 1 Central Document, Opinions of the Central Committee of the Communist Party of China and the State Council on Further Deepening Rural Reform and Steadily Advancing Comprehensive Rural Revitalization, carries forward the cause and forges ahead into the future. It anchors the goals of advancing comprehensive rural revitalization and building a strong agricultural country, clarifies reform and opening up as well as scientific and technological innovation as driving forces, and calls for in-depth study and application of the experience from the "Thousand Villages Demonstration and Ten Thousand Villages Renovation" Project. It aims to ensure national food security, prevent large-scale return to poverty, and strive to improve the levels of rural industrial development, rural construction, and rural governance, so as to lay a solid foundation for comprehensively advancing the great cause of building a strong country and national rejuvenation through Chinese-style modernization.

However, this grand process is facing an increasingly severe global challenge: climate change. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), global warming has led to a significant increase in the frequency, intensity, and duration of extreme weather events, including persistent high-temperature heatwaves, droughts, and heavy rainfall, posing unprecedented shocks to climate-sensitive agricultural production and rural life. Therefore, against the intertwined background of the two national strategies of "rural revitalization" and "climate change response", accurately identifying the impact mechanism of climate shocks on rural development has become a major practical issue related to national food security, ecological security, and social stability.

Jiangsu Province is located in the north-south climate transition zone as a whole, making it a typical "climate change sensitive area". Northern Jiangsu, situated in the northern part of the province, exhibits more pronounced transitional characteristics and climatic sensitivity. Observation data show that over the past 60 years, the annual average temperature in Jiangsu has risen by 0.3℃ per decade, and the annual number of high-temperature days (with daily maximum temperature ≥ 35℃) has increased by 1.6 days per decade. It is forecasted that during the 2025 flood season, temperatures in most parts of Jiangsu will remain 0.5–1℃ higher than the perennial average, with more high-temperature days than the same period in normal years. This means that agricultural production, energy supply, and residents' health in northern Jiangsu will face more frequent high-temperature threats. Climate risks in northern Jiangsu do not exist in isolation but often appear in compound forms. For example, in January 2025, five cities in northern Jiangsu simultaneously encountered heavy air pollution due to adverse meteorological conditions and external pollutant transport, and orange alerts were activated. In addition, during a weather process affecting Jiangsu in October 2025, multiple weather phenomena such as rainfall, strong winds, and temperature drops occurred in northern Jiangsu, significantly impacting the harvesting of corn and soybeans as well as the rush-harvesting of rice in the region. This trend of concurrent or successive extreme events amplifies the economic and social impacts.

On the other hand, northern Jiangsu contributed 53% of Jiangsu's total grain output in 2023 and is the only large-scale commodity grain base in the Yangtze River Delta, with agriculture still occupying an important position in its economic structure. Climate change directly affects agricultural production. In 2022, Suqian and Huai'an suffered a 45-day summer drought, affecting 1.87 million mu of farmland and causing yield reductions of 12% for corn and 15% for soybeans, respectively. In 2023, a typhoon passing through Yancheng caused 280,000 mu of rice to lodge, resulting in 1.26 billion yuan of direct agricultural economic losses, accounting for 34.7% of the province's total agricultural disaster losses that year. Compared with southern Jiangsu, northern Jiangsu lags behind in economic development and has a higher proportion of rural population. When coping with climate change, its infrastructure, financial resources, and adaptation technologies are often more limited, leading to higher vulnerability.

Therefore, the development status of northern Jiangsu has an important impact on regional coordination and food security in Jiangsu Province and even the Yangtze River Delta region. Focusing research on this region can provide a clear microcosm for understanding how climate shocks affect rural transformation in less-developed areas of China, and has direct practical significance for ensuring regional food security and promoting coordinated development.

In view of this, the theoretical marginal contributions of this paper are mainly reflected in two aspects. First, it constructs a county-level multidimensional poverty assessment framework and expands the dimension of benefit evaluation for climate shocks. This paper innovatively expands poverty measurement from a single economic income dimension to a multidimensional framework integrating economy, education, and health, and constructs a multidimensional poverty index applicable at the county level. This comprehensive evaluation framework breaks through the limitations of traditional research and provides a new methodological basis for comprehensively quantifying the comprehensive social costs of climate change. Second, it reveals the transmission mechanism of climate shocks affecting rural development and clarifies the "climate-agriculture-poverty" action path. Through rigorous empirical analysis, this paper verifies for the first time the key mediating role of "agricultural output" between climate shocks and multidimensional poverty in northern Jiangsu. It clarifies the transmission path through which climate change aggravates multidimensional poverty by inhibiting agricultural production efficiency and reducing agricultural economic benefits, providing a new theoretical explanation for understanding the internal mechanism of climate shocks affecting rural development. The research results provide an operable theoretical framework and empirical support for formulating policies such as industrial transformation, financial support, and infrastructure construction oriented to climate risks.

2. Literature Review

2.1. Research on the Impact of Climate Change on Agricultural Economy

Domestic and foreign scholars have conducted extensive discussions on the impact of climate change on agricultural production. A large body of literature has confirmed at both macro and micro levels that climate change is by no means a mere environmental issue, but also a profound development issue. Early studies mostly focused on the negative impacts of climate variables (such as temperature and precipitation) on macroeconomic aggregates (such as GDP and total factor productivity) (Dell et al., 2014). With the deepening of research, scholars have gradually shifted their perspective to the micro level, finding that climate shocks ultimately suppress the growth of residents' income, consumption, and well-being by damaging agricultural output (Burke and Emerick, 2016), disrupting industrial production processes, and affecting workers' health and efficiency (Heal and Park, 2016).

Some scholars have found that the impacts of climate shocks exhibit significant sectoral and regional heterogeneity. Agriculture is the sector most directly affected by climate shocks. Extreme events such as high temperature, drought, and flood directly lead to fluctuations in agricultural output and sharp declines in farmers' income by damaging crop physiological functions, altering phenological periods, and aggravating pests and diseases (Chen et al., 2016). More critically, such impacts show strong asymmetry: compared with capital-intensive and facility-based industry and service sectors, traditional agriculture based on smallholder production is more vulnerable; compared with urban areas, the deficiencies of rural areas in infrastructure, public services, financial insurance, and risk response capabilities further amplify their vulnerability, making natural risks more likely to transform into economic and social risks (Zhang et al., 2018). According to research by the Jiangsu Climate Center, there are significant differences in the types of climate risks faced by different regions: northern Jiangsu is a high-risk area for cold waves and frost disasters, while the southwest faces high risks of low temperature, rainy weather, and insufficient sunshine (Wang et al., 2023). This regional differentiation of risk types determines that targeted adaptation strategies need to be adopted in different regions. Chen and Yang (2025) point out that in response to climate change, agricultural producers will spontaneously adopt adaptation strategies such as adjusting sowing time (Burke and Emerick, 2016), replacing crop varieties (Seo and Mendelsohn, 2008b), and increasing irrigation. These strategies can alleviate the negative effects of climate change to a certain extent, but their effects are constrained by farmers' resource endowments and technology adoption capabilities. This series of studies provides solid theoretical support for this paper to focus on rural areas and select "agricultural output" as the core mediating channel.

2.2. Research on the Theoretical Evolution and Alleviation Paths of Multidimensional Poverty

The measurement of multidimensional poverty has undergone a gradual improvement process from theoretical frameworks to empirical methods. The "capability poverty" theory proposed by Sen (1999) laid the foundation for multidimensional poverty research, holding that the essence of poverty is the deprivation of basic individual "capabilities", and low income is only one manifestation. Poverty should cover multiple dimensions such as income, education, and health. On this basis, the Alkire-Foster approach proposed by Alkire & Foster (2008) has become the current mainstream measurement framework. It constructs the Multidimensional Poverty Index (MPI) by identifying poverty dimensions, setting weights and poverty cutoff values. This method has been adopted and widely used by the United Nations Development Programme (UNDP) due to its rigorous logic and strong operability.

Domestic scholars have carried out localized explorations of multidimensional poverty measurement in combination with China's national conditions. Early studies mostly drew on the Alkire-Foster approach to construct indicator systems from dimensions such as income, education, health, and living standards (Wang and Alkire, 2009). Later, on this basis, domestic scholars constructed many county-level multidimensional development evaluation indicator systems applicable to China's context (Wang and Feng, 2020; Zhuang et al., 2025), and mainly used the fuzzy set method, comprehensive index method, and dual cutoff method (also known as the A-F method) to aggregate and calculate the multidimensional poverty index. Based on data availability and problem orientation, existing studies mostly select dimensions such as education, health, and living standards (Zhong and Lin, 2020; Zou et al., 2023), while some studies select dimensions such as income, employment, social security, and social environment (Wang and Sun, 2021; Wang and Xu, 2022). This enlightens us that to evaluate the impact of climate events on rural revitalization, we must go beyond single indicators such as agricultural output value or farmers' income, and instead adopt a multidimensional evaluation framework that can reflect the overall well-being of the rural system. This is not only an inevitable theoretical requirement, but also enables more accurate identification of the differentiated impacts of climate shocks across different dimensions, providing targets for precise policy implementation.

The development and progress of rural areas and the implementation of the rural revitalization strategy are widely regarded as important ways to alleviate relative poverty. A large number of empirical studies have been carried out around dimensions such as industrial structure, technological progress, organizational forms, and digitalization, forming a relatively systematic theoretical and empirical framework. First, in terms of industrial development and organizational innovation, characteristic agriculture is regarded as a key path for the state to support industrial revitalization in less-developed areas. Xu and Yu (2024) point out that developing characteristic agriculture can effectively alleviate farmers' multidimensional relative poverty through three effects: circular accumulation of capabilities, optimal allocation of factors, and improvement of spiritual literacy. The study constructs a three-level analytical framework of "poverty causes - poverty reduction mechanism - governance logic", providing methodological reference for subsequent empirical research on industrial structure and poverty governance. Kuang and Ji (2024) emphasize that the new rural collective economy significantly promotes relative poverty governance by enhancing agricultural investment, creating local employment, increasing farmers' operating income, and cultivating endogenous motivation for poverty alleviation. Second, agricultural technological progress is the only way to realize agricultural modernization, but its impact on relative poverty is restricted by path selection and production conditions. Ji et al. (2023) find that agricultural mechanization generally helps alleviate relative poverty, and compared with purchasing agricultural machinery by oneself, purchasing socialized services has a more significant poverty reduction effect. In summary, existing studies have systematically revealed the mechanism of rural revitalization in alleviating relative poverty from multiple paths such as industry and technology, providing a solid theoretical reference for this study to explore multidimensional poverty in northern Jiangsu under the background of climate shocks.

3. Research Design and Data Description

3.1. Sample Selection and Data Sources

3.1.1. Sample Scope and Time Interval

This study takes northern Jiangsu Province as the research object, which includes all county-level units under the jurisdiction of five prefecture-level cities: Xuzhou, Lianyungang, Suqian, Huai'an, and Yancheng. The research sample constitutes a balanced panel dataset with a time span of 24 years from 2000 to 2023. The selection of this time interval is based on the following considerations. First, China's urbanization and agricultural modernization have accelerated in recent years, bringing profound changes to the rural socio-economic structure. Second, this period covers the frequent occurrence of extreme high-temperature events under the background of climate change, which can effectively capture the dynamic impacts of climate shocks. Finally, the statistical indicator system during this period is relatively complete and stable, ensuring the continuity and comparability of data. After data cleaning and matching, the final number of valid observations included in the model is 888.

3.1.2. Variable Definition and Data Sources

(1) Data Sources

The data required for this study are sourced as follows. The basic indicator data of the explained variable, agricultural output data, and control variable data are mainly derived from the China County Statistical Yearbook and Jiangsu Statistical Yearbook. Missing data are supplemented by the linear interpolation method to ensure sample integrity. The original meteorological data of the core explanatory variables (high-temperature days, cooling degree days) come from the China Surface Climate Data Daily Dataset (V3.0) of the National Meteorological Science Data Center of China Meteorological Administration. The data are processed using the Inverse Distance Weighting (IDW) method: corresponding meteorological stations are matched according to the geographical location of county administrative centers, and county-level panel data are obtained through calculation.

(2) Variable Definition

① Explained Variable

The core explained variable of this study is the Multidimensional Poverty Index (MPI). Proposed by the Oxford Poverty and Human Development Initiative (OPHI) in 2010, the MPI was applied to the Human Development Report of the United Nations Development Programme (UNDP) starting from 2011, replacing the Human Poverty Index (HPI) that had been used since 1997 (Zhang and Zhou, 2014). It is constructed based on five basic indicators, specifically:

Economic development dimension: per capita disposable income of rural residents (yuan). This indicator directly reflects the income level of rural residents in the county and is the core dimension for measuring economic poverty.

Educational resource dimension: total number of primary and secondary schools (units), number of full-time teachers in primary and secondary schools (persons), and number of students in primary and secondary schools (persons). The three indicators jointly reflect the scale of educational facilities, teacher allocation, and service coverage capacity at the county level.

Medical resource dimension: number of beds in hospitals and township health centers (beds). This indicator directly measures the supply capacity and accessibility of county-level medical and health services, and is a key indicator for measuring medical poverty.

Based on the above indicators, this study uses the entropy method to construct a comprehensive multidimensional poverty index. This method assigns objective weights according to the variation degree of each indicator's observed values, which can effectively overcome the bias caused by subjective judgment and ensure the scientificity and fairness of evaluation results. MPI covers the above five basic indicators, while MPI1 only retains the total number of schools in the educational resource dimension to avoid potential multicollinearity problems. Both indices are synthesized by weighting the standardized original indicators, ensuring the objectivity and comparability of the indices.

② Core Explanatory Variables

The core explanatory variables are indicators related to high-temperature weather, specifically including:

High-temperature days (High_temp): defined as the number of days in a year when the daily maximum temperature exceeds 35℃ in county-level rural areas of northern Jiangsu.

Cooling Degree Days (CDD26): defined as the cumulative value of the difference between the daily average temperature and the baseline temperature for days when the daily average temperature exceeds 26℃ in a year (unit: ℃·d). The calculation formula is:

$$\mathrm{CDD26}=\sum_{t=1}^{365}\max(0,T_t\text{-}26) \tag{1}$$

where T_t is the average temperature on day t. CDD26 is calculated from raw data and can more accurately reflect the cumulative effect of high-temperature events.

③ Mediating Variable Data

This study introduces agricultural output (Agri_output) as the mediating variable, measured by the proportion of added value of the primary industry in regional GDP, and takes its natural logarithm to smooth the data.

④ Control Variable Data

To control for the influence of other potential confounding factors, we introduce control variables covering three dimensions: economic development level, population and labor structure, and agricultural and economic resilience.

Economic development level indicators: per capita regional GDP, with its natural logarithm taken to alleviate heteroscedasticity; per capita budget expenditure, calculated as "local fiscal general budget expenditure / total population at year-end".

Population and labor structure indicator: rural population share, calculated as "rural population / total population at year-end".

Agricultural and economic resilience indicators: per capita cultivated land area, calculated as "cultivated land area / total population at year-end"; per capita agricultural machinery power, calculated as "total agricultural machinery power/ total population at year-end".

3.2. Construction of the Entropy Method

The entropy method is an objective weighting method. Its basic idea is to determine weights according to the amount of information provided by the observed values of each indicator. The greater the variation degree of an indicator (i.e., the smaller the information entropy), the more information it can provide, the greater its role in comprehensive evaluation, and the higher its weight should be. This method can effectively avoid deviations caused by human subjective factors and make evaluation results more objective and credible (Zou et al., 2006).

The weighted summation formula is used to calculate the comprehensive score of each sample, namely the Multidimensional Poverty Index (MPI) in this study. This index comprehensively reflects the overall poverty status of each county in the three dimensions of economic development, education, and medical care. A higher MPI value indicates a deeper degree of multidimensional poverty in the region; conversely, a lower MPI value indicates a better development level and a lighter degree of poverty.

3.3. Model Construction

To empirically test the impact of high-temperature weather on county-level poverty, this study constructs the following two-way fixed effects panel model:

$$\mathrm{MPI_i} = \mathrm{Composite\ Score_i} = \sum_{j=1}^{n}(w_j \times x'_{ij}) \tag{2}$$

where i and t represent county and year, respectively; MPI_{it} is the multidimensional poverty index of county i in year t; $\mathrm{High\_Temp}_{it}$ is the number of high-temperature days (days with daily maximum temperature exceeding 35℃) of county i in year t; $\mathrm{Controls}_{it}$ represents control variables; μ_{i1} and λ_{t1} are county fixed effect and year fixed effect, respectively; ε_{it1} is the random error term, and cluster-robust standard errors clustered at the county level are used to address potential heteroscedasticity and autocorrelation.

To test the transmission path of "high temperature - agricultural output - multidimensional poverty", the two-step mediation effect method proposed by Jiang (2022) is adopted for robust testing. Its core advantage is that it avoids the bias of the traditional three-step method that "denies the mediation effect if the total effect is not significant", and focuses more on the economic essence of the mediation path. The model is divided into two parts:

$$\mathrm{Agri\_output}_{it} = \alpha_2 + \beta_2 \mathrm{High\_Temp}_{it} + \delta_2 \mathrm{Controls}_{it} + \mu_{i2} + \lambda_{t2} + \varepsilon_{it2} \quad (3)$$

$$\mathrm{MPI}_{it} = \alpha_3 + \beta_3 \mathrm{High\_Temp}_{it} + \xi_3 \mathrm{Agri\_output}_{it} + \delta_3 \mathrm{Controls}_{it} + \mu_{i3} + \lambda_{t3} + \varepsilon_{it3} \quad (4)$$

where $\mathrm{Agri\_output}_{it}$ is the mediating variable of agricultural output. Equation (3) tests the impact of high-temperature weather on agricultural output. Compared with Equation (2), Equation (4) adds the variable $\mathrm{Agri\_output}_{it}$ to illustrate the impact of the mediating variable on the explained variable after controlling for high-temperature weather.

4. Empirical Results and Analysis

4.1. Baseline Regression Results

Table 1 reports the baseline regression results of the impact of high-temperature weather on poverty in counties of northern Jiangsu. To rigorously examine the stability of the relationship between core variables, we estimate by gradually adding control variables. Column (1), which only controls the core explanatory variable, shows that the coefficient of high-temperature days is 0.0016, which is significantly positive at the 1% level. This preliminary result indicates a significant positive correlation between high-temperature weather and the Multidimensional Poverty Index. Since a higher MPI value represents a deeper degree of poverty, this positive coefficient means that the increase in high-temperature weather significantly aggravates the degree of multidimensional poverty in the region.

Columns (2) to (4) gradually introduce control variables such as economic development, population structure, and agricultural economic resilience. The results show that the coefficient of high-temperature days is significantly positive at the 1% level under all specifications, indicating that the aggravating effect of high temperature on multidimensional poverty is not interfered by other variables. In Column (2), after adding economic development level variables, the coefficient of high-temperature days decreases slightly but remains highly significant, which preliminarily proves the robustness of the core results. Notably, the coefficients of economic development level variables present an enlightening pattern: per capita GDP (Ln_gdp_per) is significantly positively correlated with MPI, which is consistent with theoretical expectations; while the coefficient of per capita budget expenditure (Expenditure_per) is significantly negative, which may imply that during the sample period, public fiscal expenditure tended to areas with more severe poverty to a certain extent, reflecting the transfer payment and redistribution functions of finance.

In the full model of Column (4), the coefficient of rural population share (Rural_share) becomes significantly positive after adding agricultural and economic resilience variables. This finding may reflect the scale effect brought by rural population agglomeration and the improvement of rural endogenous development vitality under the background of rural revitalization. With the improvement of rural infrastructure and public services, moderate population agglomeration may promote rural development through channels such as knowledge spillovers and market access.

Of particular concern is that the coefficients of per capita cultivated land area (Land_per) and per capita agricultural machinery power (Agri_machine_per) are both significantly negative. This finding has important policy implications: it suggests that in northern Jiangsu, traditional agricultural development models that simply rely on expanding cultivated land scale or improving agricultural mechanization have limited effects on alleviating multidimensional poverty covering education and health. On the contrary, excessive reliance on traditional agricultural paths may inhibit the diversified development of regional economy and the expansion of residents' capabilities due to reasons such as resource misallocation and technology path dependence. This result is consistent with the strategic direction of promoting agricultural and rural modernization in the new development stage, reminding us that we need to go beyond traditional agricultural modernization thinking and seek more comprehensive rural development paths.

Table 1. Baseline Regression Results

VARIABLES	(1) MPI	(2) MPI	(3) MPI	(4) MPI
High_temp	0.0016***	0.0014***	0.0014***	0.0013***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Ln_gdp_per		0.0276***	0.0268***	0.0111*
		(0.0069)	(0.0065)	(0.0066)
Expenditure_per		-0.0380***	-0.0388***	-0.0222***
		(0.0063)	(0.0062)	(0.0055)
Rural_share			0.0161	0.1081***
			(0.0187)	(0.0190)
Land_per				-0.0001***
				(0.0000)
Agri_machine_per				-0.0105**
				(0.0047)
Constant	0.2364***	-0.0226	-0.0280	0.1644**
	(0.0033)	(0.0699)	(0.0722)	(0.0732)
Observations	888	888	888	888
R-squared	0.9459	0.9497	0.9497	0.9532

Note: Numbers reported in parentheses are standard errors. *p < 0.1, **p < 0.05, ***p < 0.01.

4.2. Robustness Checks

To ensure the reliability of the baseline regression conclusions, this study conducts two robustness checks from the perspective of core variable measurement. First, replace the core explanatory variable. The high-temperature days (High_temp) used in the baseline regression is a count indicator based on a specific threshold (35℃). Although intuitive, it cannot fully capture the continuous cumulative effect of temperature. To this end, this study adopts Cooling Degree Days (CDD26) as an alternative climate shock indicator. This indicator comprehensively considers the magnitude and duration of daily average temperature exceeding 26℃, and can more accurately measure the degree of impact on human comfort as well as corresponding energy demand and economic and social costs, which is widely used in climate economics research. Second, replace the explained variable (poverty measurement indicator). To test whether the research conclusion depends on the specific construction method of the Multidimensional Poverty Index (MPI), this study constructs a simplified multidimensional poverty index MPI1 by adjusting the indicator composition. This index retains the core indicators of the economic development dimension (income) and medical resource dimension (hospital), but only retains the total number of schools (school) in the educational resource dimension, to avoid the potential problem of "indicator redundancy in the education dimension".

Table 2 reports the regression results using CDD26 instead of High_temp. The results show that the coefficient of CDD26 is always significantly positive at the 1% level. For each 1℃·d increase in CDD26 (i.e., a 1-unit increase in the cumulative value of high-temperature intensity and duration), MPI increases significantly by 0.0002 (Column 4). This means that the cumulative effect of high temperature will lead to a decline in the improvement of MPI, that is, aggravated multidimensional poverty, which is consistent with the baseline regression results and further enhances the credibility of the research conclusion.

Table 2. Robustness Check: Replacement of Temperature Variable

VARIABLES	(1) MPI	(2) MPI	(3) MPI	(4) MPI
CDD26	0.0003***	0.0002***	0.0002***	0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Ln_gdp_per		0.0254***	0.0247***	0.0100
		(0.0070)	(0.0067)	(0.0069)
Expenditure_per		-0.0374***	-0.0382***	-0.0225***
		(0.0064)	(0.0063)	(0.0055)
Rural_share			0.0149	0.1046***
			(0.0187)	(0.0192)
Land_per				-0.0001***
				(0.0000)
Agri_machine_per				-0.0101**
				(0.0049)
Constant	0.2087***	-0.0193	-0.0243	0.1648**
	(0.0077)	(0.0713)	(0.0736)	(0.0756)
Observations	888	888	888	888
R-squared	0.9457	0.9490	0.9491	0.9524

Note: Numbers reported in parentheses are standard errors. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 3 presents the regression results using MPI1 as the explained variable. The results show that the coefficient of the core explanatory variable High_temp remains significantly positive at the 1% level under all model specifications. This result clearly indicates that even if the measurement framework of multidimensional poverty is changed, the aggravating effect of high-temperature shocks on poverty still exists, and the core research findings are quite robust. The construction of MPI1 excludes potential redundant indicators in the education dimension, but the core conclusion remains unchanged, indicating that the original MPI indicator system is reasonably designed and there is no conclusion bias caused by excessive indicators.

Table 3. Robustness Check: Replacement of Poverty Variable

VARIABLES	(1) MPI1	(2) MPI1	(3) MPI1	(4) MPI1
High_temp	0.0017***	0.0015***	0.0015***	0.0012***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Ln_gdp_per		0.0424***	0.0427***	0.0303***
		(0.0088)	(0.0082)	(0.0082)
Expenditure_per		-0.0418***	-0.0415***	-0.0168***
		(0.0074)	(0.0071)	(0.0060)
Rural_share			-0.0061	0.1178***
			(0.0242)	(0.0246)
Land_per				-0.0001***
				(0.0000)
Agri_machine_per				-0.0416***
				(0.0051)
Constant	0.1974***	-0.2092**	-0.2071**	-0.0598
	(0.0041)	(0.0900)	(0.0956)	(0.0968)
Observations	888	888	888	888
R-squared	0.9426	0.9477	0.9477	0.9536

Note: Numbers reported in parentheses are standard errors. *p < 0.1, **p < 0.05, ***p < 0.01.

4.3. Analysis of Impact Mechanisms

To further reveal the internal mechanism of high-temperature weather affecting multidimensional poverty, this study further empirically tests the mediation effect of agricultural output. Combined with this study, the county economy of northern Jiangsu is dominated by agriculture. High-temperature weather directly inhibits agricultural output by suppressing crop growth (e.g., yield reduction, quality decline) and reducing agricultural labor productivity. Agricultural output is the core source of farmers' income and an important support for county-level investment in education and medical public services. The decline in agricultural output will further aggravate the "economic-educational-medical" multidimensional poverty. Therefore, agricultural output is set as the mediating variable to test the transmission path of "high-temperature weather - inhibiting agricultural output - aggravating multidimensional poverty".

Column (1) reports the total effect of high-temperature weather on multidimensional poverty. The coefficient of high-temperature days (High_temp) is 0.0012, significant at the 1% level, which is consistent with the baseline regression conclusion. This result verifies that the total effect of high-temperature events on multidimensional poverty is "aggravation", providing a prerequisite for the mediation effect test.

In Column (2), the coefficient of High_temp is -0.0245, significant at the 5% level, indicating that for each additional day of high temperature, the proportion of agricultural output decreases by approximately 0.0245 units. That is, high-temperature events exert a significant negative impact on agricultural output by suppressing crop growth and reducing agricultural labor productivity, thereby aggravating multidimensional poverty. Economic development level has a significant positive impact on agricultural output, indicating that economically developed areas may partially alleviate the impact of high-temperature shocks through stronger agricultural science and technology investment and infrastructure support. Rural population share (Rural_share) is significantly negatively correlated with agricultural output. This finding challenges traditional cognition, suggesting that the development model that simply relies on intensive input of agricultural labor can no longer cope with climate shocks, highlighting the importance of technological innovation. Agricultural mechanization significantly increases agricultural output, reflecting the positive role of modern agricultural equipment in coping with climate risks and providing empirical support for technology adaptation paths.

Table 4. Test Results of Mediation Effect 1

	(1) MPI	(2) agri_output
High_temp	0.0012***	-0.0245**
	(0.0003)	(0.0097)
Ln_gdp_per	0.0022	0.5019***
	(0.0083)	(0.1278)
Expenditure_per	-0.0193***	-0.1901*
	(0.0055)	(0.0000)
Rural_share	0.1177***	-1.1489***
	(0.0188)	(0.4379)
Land_per	-0.0001***	0.0004
	(0.0000)	(0.0003)
Agri_machine_per	-0.0079*	0.3438***
	(0.0046)	(0.0771)
Constant	0.2519***	8.0079***
	(0.0884)	(1.2601)
Observations	888	888
R-squared	0.9573	0.7728

Note: Numbers reported in parentheses are standard errors. *p < 0.1, **p < 0.05, ***p < 0.01.

This study introduces "number of employees in agriculture, forestry, animal husbandry and fishery (Agri_labor)" as the second mediating variable, aiming to test the transmission path of "high-temperature weather - agricultural labor structure adjustment - multidimensional poverty". Its theoretical logic is as follows: by directly damaging crop growth and reducing tolerance for outdoor work, high-temperature weather may force some agricultural labor to withdraw or transfer, thereby reducing effective labor input in the agricultural sector. The contraction of agricultural employment opportunities not only directly weakens farmers' income base, but may also affect families' investment capacity in development such as education and medical care due to idle or inefficient labor transfer, thus aggravating poverty at multiple dimensions.

Table 5 reports the test results with Agri_labor as the mediating variable. In Column (1), the coefficient of high-temperature days (High_temp) is 0.0013 ($p<0.01$), which is completely consistent with the core conclusion of the baseline regression, indicating that the aggravating effect of high temperature on multidimensional poverty is significant and provides a necessary prerequisite for the mediation effect test. In Column (2), the coefficient of high-temperature days on the number of employees in agriculture, forestry, animal husbandry and fishery is -0.0025, significant at the 5% level. This indicates that for each additional day of high temperature, the number of employees in agriculture, forestry, animal husbandry and fishery decreases significantly by 0.0025 units. This directly verifies the inhibitory effect of high temperature on agricultural labor supply: in high-temperature environments, farmers will shorten outdoor working hours to avoid the risk of heat stroke, and some elderly and frail employees even temporarily withdraw from agricultural labor, resulting in a reduction in the number of employees and weakening the stability and sustainability of farmers' livelihoods.

Combining Column (1) and Column (2), it can be seen that "agricultural labor" is an important mediating channel through which high-temperature shocks affect multidimensional poverty. High temperature not only directly inhibits agricultural production, but may also indirectly aggravate poverty by changing the labor market structure, that is, reducing employment opportunities in the agricultural sector. This reminds policymakers that when coping with climate risks, they should not only pay attention to agricultural output itself, but also attach importance to the protection and guidance of agricultural labor employment, and alleviate the negative impact of high temperature on rural employment through skills training and non-agricultural employment connection.

Table 5. Test Results of Mediation Effect 2

	(1) MPI	(2) Agri_labor
High_temp	0.0013***	-0.0025**
	(0.0003)	(0.0012)
Ln_gdp_per	0.0111*	0.2058***
	(0.0066)	(0.0300)
Expenditure_per	-0.0222***	-0.0475*
	(0.0055)	(0.0245)
Rural_share	0.1081***	1.1168***
	(0.0190)	(0.1229)
Land_per	-0.0001***	-0.0007***
	(0.0000)	(0.0001)
Agri_machine_per	-0.0105**	-0.0001
	(0.0047)	(0.0236)
Constant	0.1644**	9.7431***
	(0.0732)	(0.3594)
Observations	888	888
R-squared	0.9532	0.9576

Note: Numbers reported in parentheses are standard errors. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

This study further examines the mediating role of "urban and rural residential electricity consumption (Household_electricity)" to reveal the transmission path of "high-temperature weather - increased household energy expenditure - multidimensional poverty". Its theoretical logic is that extreme high temperature significantly drives up household cooling demand, leading to a surge in residential electricity consumption. This additional energy expenditure may squeeze the already limited household budget, forcing families to cut necessary expenses on education, medical care, nutrition, etc., thereby damaging their long-term development capacity and falling into or deepening poverty in multiple dimensions.

Table 6 shows the test results with Household_electricity as the mediator. The coefficient of high-temperature days on Household_electricity is 0.0030 and significant at the 1% level. This positive and significant relationship is the core evidence, indicating that for each additional day of high-temperature weather, urban and rural residential electricity consumption increases significantly by 0.0030 units on average. Empirical evidence proves that high temperature increases residents' living costs by driving up household energy consumption, constituting a financial pressure channel that aggravates poverty. This mechanism analysis shows that "household energy expenditure" is another effective mediating path through which high temperature affects multidimensional poverty. By inducing additional household cooling energy consumption, high temperature directly increases living costs, which may impose significant budget constraints on low-income families and force them to make difficult choices between "maintaining basic living comfort" and "investing in human capital". This highlights the importance of ensuring energy accessibility in rural areas, promoting energy-saving technologies, and providing energy subsidies for vulnerable families in the context of climate warming, so as to buffer the erosion effect of energy poverty on multidimensional development.

Table 6. Test Results of Mediation Effect 3

	(1) MPI	(2) Household_electricity
High_temp	0.0013***	0.0030***
	(0.0003)	(0.0004)
Ln_gdp_per	0.0111*	0.0803***
	(0.0066)	(0.0088)
Expenditure_per	-0.0222***	0.0006
	(0.0055)	(0.0086)
Rural_share	0.1081***	0.1154***
	(0.0190)	(0.0329)
Land_per	-0.0001***	-0.0001***
	(0.0000)	(0.0000)
Agri_machine_per	-0.0105**	-0.0731***
	(0.0047)	(0.0072)
Constant	0.1644**	9.7822***
	(0.0732)	(0.0909)
Observations	888	888
R-squared	0.9532	0.9423

Note: Numbers reported in parentheses are standard errors. *p < 0.1, **p < 0.05, ***p < 0.01.

5. Conclusions and Implications

This study systematically examines the impact of high temperature on the rural revitalization process in northern Jiangsu and its mechanisms. The main conclusions are as follows. First, high temperature is a key external stress factor aggravating multidimensional poverty in counties of northern Jiangsu, exerting a significant impact on the rural revitalization process. As an agriculture-dominated less-developed region, counties in northern Jiangsu are more sensitive to high temperature due to their vulnerabilities in economic development, education supply, and medical services. High temperature directly amplifies the development gap of counties in the dimension of multidimensional poverty. Second, high temperature aggravates multidimensional poverty through three paths, forming a chain impact of "climate - livelihood - development": inhibiting agricultural output - high temperature directly damages crop growth and production efficiency, reduces the contribution of agriculture to the economic structure, and weakens the rural economic foundation; reducing agricultural labor supply - high temperature causes some labor to withdraw or transfer, reduces the stability of agricultural employment, and affects families' sustainable livelihoods; driving up residential electricity costs - high temperature increases household cooling energy consumption, squeezes developmental expenditures such as education and medical care, and aggravates energy poverty and multidimensional deprivation. The above findings reveal that the impact of high temperature on rural areas is not a single dimension, but is transmitted through multiple channels of production, employment, and life, ultimately deepening poverty in income, education, health and other aspects. This suggests that systematic and multi-dimensional governance strategies are needed to cope with climate shocks. Based on the above research conclusions, this study puts forward the following targeted policy recommendations. In response to the problem that high temperature inhibits agricultural output and labor supply, it is necessary to accelerate the breeding of high-temperature-resistant and water-saving crop varieties, and promote facility agricultural technologies such as shade nets and sprinkler-drip irrigation to reduce the impact of climate on agricultural production; meanwhile, combined with agricultural technology training and industrial diversification, guide agricultural labor to transfer to fields such as agricultural product processing and rural tourism to alleviate employment pressure. In response to the problem that high temperature drives up household electricity expenditure, seasonal electricity price subsidies or energy-saving equipment subsidies can be provided for vulnerable groups such as low-income farmers and the elderly, and clean energy such as solar energy and biomass energy can be promoted to reduce their energy burden; meanwhile, improve rural power grid facilities and enhance power supply reliability. In response to the impact of high temperature on public services such as education and medical care, ventilation and cooling transformation should be promoted in public places such as primary and secondary schools and township health centers, and rural public heat shelters should be set up; climate-adaptive designs, such as greening for cooling and building thermal insulation, should be incorporated into planning and construction to systematically improve the safety and comfort of the rural living environment under extreme high temperatures.

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