

The Impact of Territorial Ecological Protection and Restoration on Economic Development in China's Poverty-Alleviated Areas: An Empirical Analysis Based on the PSM-DID Method (Postprint)

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Abstract

Investigating the impact of territorial ecological protection and restoration on economic development in China's poverty-alleviated areas can provide scientific evidence for the sustainable economic development of these regions and rural revitalization efforts in relatively impoverished areas during the post-poverty-alleviation era. Using the Propensity Score Matching-Difference-in-Differences (PSM-DID) model, this study measures the impact of territorial ecological protection and restoration on economic development in China's poverty-alleviated areas by comparing the 2010–2020 economic panel data of 58 national-level poverty-alleviated counties involved in the first and second batches of national integrated protection and restoration projects for mountains, rivers, forests, farmlands, lakes, grasslands, and deserts (“Landscape Project”) during the 13th and 14th Five-Year Plan periods, with that of 182 poverty-alleviated counties with similar natural and socioeconomic baseline conditions that were not included in the national “Landscape Project.” The results indicate: (1) *Ceteris paribus*, the economic growth rate of poverty-alleviated counties that implemented territorial ecological protection and restoration increased significantly by 0.0329 compared with those that did not, and this conclusion remains robust after conducting balance tests, parallel trend tests, placebo tests, and other robustness checks. (2) Both short-term and long-term effects of project implementation on economic development should be considered in territorial ecological protection and restoration. As an important means to sustainably promote economic development in poverty-alleviated areas, the realization of ecological product value should be supported with more policy incentives on the basis of

improving relevant institutional frameworks, to facilitate the transformation of “lucid waters and lush mountains” into “golden and silver mountains.”

Full Text

Impact of Territorial Spatial Ecological Protection and Restoration on Economic Development in China’s Poverty-Alleviated Regions: An Empirical Analysis Based on the PSM-DID Method

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Abstract: Exploring the impact of territorial spatial ecological protection and restoration on economic development in China’s poverty-alleviated regions provides a scientific basis for promoting sustainable economic development and rural revitalization in these areas during the post-poverty era. Using the propensity score matching–difference-in-differences (PSM-DID) model, this study compares economic panel data from 2010 to 2020 for 58 national-level poverty-alleviated counties involved in the first and second batches of national integrated protection and restoration projects for mountains, rivers, forests, farmlands, lakes, grasslands, and deserts (the “Shanshui Project”) during China’s 13th and 14th Five-Year Plans, with 182 similar counties not included in the national “Shanshui Project.” The results show that: (1) Under otherwise unchanged conditions, the economic development rate of poverty-alleviated counties implementing territorial spatial ecological protection and restoration increased significantly by 0.0329 compared to regions without such implementation. This conclusion remains robust after balance tests, parallel trend tests, and placebo tests. (2) Both short-term and long-term economic effects should be considered in implementing territorial spatial ecological protection and restoration. Realizing ecological product value is a crucial means of sustainably promoting economic development in poverty-alleviated regions. Based on improving relevant ecological product value realization systems, these areas should receive more policy support to facilitate the transformation of “green waters and mountains” into “golden mountains and silver mountains.”

Keywords: territorial spatial ecological protection and restoration; poverty-alleviated regions; economic development; PSM-DID

Introduction

Since the 18th National Congress of the Communist Party of China, under the guidance of Xi Jinping’s ecological civilization thought, China’s territo-

rial spatial ecological protection and restoration efforts have achieved historic accomplishments. On December 13, 2022, during the second phase of the 15th Conference of the Parties to the UN Convention on Biological Diversity, China announced that the “China Mountains-Rivers-Forests-Farmlands-Lakes-Grasslands Integrated Protection and Restoration Project” (hereinafter referred to as the “Shanshui Project”), which embodies the life community concept, had been selected as one of the first ten UN World Restoration Flagship Projects. This demonstrates that China’s territorial spatial ecological protection and restoration projects are providing solutions and wisdom for global ecosystem protection and restoration. China’s ecological protection and restoration projects are mainly distributed in ecologically sensitive areas and important ecological function zones, which geographically overlap significantly with China’s poverty-stricken areas. Before implementing the poverty alleviation strategy, more than 80% of the nation’s absolute poor population resided in ecologically fragile areas. Therefore, in the new era, China’s territorial spatial ecological protection and restoration work has been highly integrated with the national poverty alleviation development strategy. This integration has not only laid a solid green foundation for building a beautiful China but also promoted sustainable socio-economic development in poverty-alleviated regions.

Analyzing the impact of territorial spatial ecological protection and restoration on regional economic development is an important issue that requires attention for rural revitalization work in relatively poor areas during the post-poverty era. However, current theoretical research on this question has not yet been reported. Regarding China’s territorial spatial ecological protection and restoration, scholars have proposed major theories based on the concept that “mountains, rivers, forests, farmlands, lakes, and grasslands form a life community,” including landscape pattern and process coupling, landscape multifunctionality, landscape sustainability, and ecological resilience. Building on this foundation, scholars have explored protection and restoration methods from perspectives such as resource constraints, restoration objectives, and restoration approaches, proposing nature-based solutions under rigid ecological constraints, ecological protection and restoration mode selection from an ecological resilience perspective, and research pathways for territorial spatial ecological protection and restoration layout that couples social-ecological objectives.

Regarding the sustainable development of socio-economics in poverty-alleviated regions, scholars have proposed that consolidating poverty alleviation achievements and establishing long-term poverty alleviation mechanisms are the cornerstones of sustainable development in these areas, examining issues such as poverty alleviation stability and long-term mechanisms. From the perspective of the relationship between territorial spatial ecological protection and restoration and regional socio-economic development, scholars have primarily focused on ecological product value realization pathways, existing problems, and policy optimization. The core arguments include: ecological protection and restoration enhance ecological product value, while ecological product value realization is an important pathway for transforming “green waters and mountains”

into “golden mountains and silver mountains” and serves as a crucial means for poverty-alleviated households to increase income beneficially. Overall, while scholars have focused on theories and methods of territorial spatial ecological protection and restoration and the ecological product value realization mechanism within this context, they have not clearly answered the effect of territorial spatial ecological protection and restoration on regional economic development or systematically revealed its mechanisms of action on economic development in poverty-alleviated regions.

To address these research gaps, this study takes China’s flagship territorial spatial ecological protection and restoration project—the national-level “Shanshui Project”—as an example. Using the PSM-DID model, we analyze economic panel data from the first, second, and third batches during the 13th Five-Year Plan period and the first and second batches during the 14th Five-Year Plan period. The study involves 58 national-level poverty-alleviated counties included in the “Shanshui Project” and 182 similar counties not included, comparing data from 2010 to 2020 to measure the impact of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions and deconstruct its mechanisms of action.

1.1 Study Area

This study selected 58 national-level poverty-alleviated counties involved in the five batches of national “Shanshui Projects” during the 13th and 14th Five-Year Plan periods and 182 poverty-alleviated counties not included in the national “Shanshui Projects” during the same period as research subjects. The 58 counties involved in the “Shanshui Project” were designated as the treatment group, while the 182 counties not included were designated as the control group. Specific information about the treatment and control groups is presented in Table 1.

1.2 Data Sources

The economic data for poverty-alleviated counties from 2010 to 2020 (including year-end loans from financial institutions, urban and rural residents’ savings deposit balances, local general budget expenditures, gross regional product, total retail sales of consumer goods, total industrial output value, number of employees in agriculture, forestry, animal husbandry, and fishery, and year-end total population) were obtained by compiling the China County Statistical Yearbook, China Regional Economic Statistical Yearbook, provincial and municipal statistical yearbooks, and county-level statistical yearbooks, with statistical analysis performed on historical data. Terrain relief data for 2015 were obtained from the Resource and Environment Science Data Platform of the Chinese Academy of Sciences (<https://www.resdc.cn>).

1.3 Indicator Selection

Explained Variable. Economic development level in poverty-alleviated regions: This study measures county-level economic development using the ratio of the current year's gross regional product (GDP) to the previous year's GDP. If the ratio is greater than 1, it indicates positive GDP growth, with larger ratios representing higher economic development levels; if the ratio is less than 1, it indicates negative GDP growth, with smaller ratios representing greater decline.

Explanatory Variable. Territorial spatial ecological protection and restoration: The impact of ecological protection and restoration on economic development in poverty-alleviated regions is measured using the interaction term between "whether receiving territorial spatial ecological protection and restoration" and "the year of implementation" (the time-policy interaction term). After PSM screening, the regression coefficient of the DID model is used to assess the impact. A positive regression coefficient indicates that territorial spatial ecological protection and restoration can improve economic development in poverty-alleviated regions.

Control Variables. In addition to territorial spatial ecological protection and restoration policies, local economic and social development also affects county-level economic growth. For example, regional economic development may increase income for impoverished populations, while development of local industrial enterprises may create employment opportunities and increase income for the poor. Enhanced local government fiscal capacity may provide more public services to alleviate poverty. Additionally, terrain relief is an important factor affecting regional economic development. Therefore, to more scientifically assess the impact of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions, this study selects the following control variables: terrain relief, financial risk, government size, industrial structure, total retail sales of consumer goods, consumption capacity, and the proportion of industrial output value to GDP.

Other Variables. In constructing the multi-period DID model, to more accurately estimate treatment effects and reduce the impact of time trends on results, time dummy variables should be included. Simultaneously, to control for potential effects of time-invariant individual-level fixed characteristics on results, policy dummy variables are introduced. The descriptive statistics for all variables are presented in Table 2.

1.4.1 Basic Principle of the PSM-DID Method

The combination of propensity score matching (PSM) and difference-in-differences (DID) methods is commonly used to evaluate policy or reform effects. This study employs the PSM-DID method to analyze the impact of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions. First, PSM is used to match the

treatment group with similar control groups to identify the most comparable individuals—that is, to find the most similar counties between ecological protection and restoration areas and non-restoration areas, ensuring consistency in all characteristics except “whether receiving territorial spatial ecological protection and restoration.” Additionally, the PSM-DID method can effectively avoid endogeneity issues between territorial spatial ecological protection and restoration and regional economic development. This study uses the implementation of “territorial spatial ecological protection and restoration” in 2016 as a policy shock, applying the PSM method to match counties that implemented ecological protection and restoration with those that did not. Nearest neighbor matching and caliper matching are used, with specific steps: (1) Select terrain relief, financial risk, government size, industrial structure, total retail sales of consumer goods, consumption capacity, and proportion of industrial output value to GDP as matching variables, with the radius set to 0.01; (2) Calculate propensity scores based on the explained variable (GDP growth rate) and control variables; (3) Match control group individuals to treatment group individuals based on the obtained propensity scores.

Based on data within the common support domain, the study uses STATA software to perform DID estimation on matched treatment and control groups after removing unmatched samples, analyzing the impact effect of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions. The model is specified as:

$$Gdpinit = \beta_0 + \beta_{1DID} + \sum \beta_{2i}Control + \sum \beta_{3i}time + \sum r_i + \varepsilon_{it}$$

where the explained variable $Gdpinit$ represents the economic development level of county i in year t ; the explanatory variable interaction term DID measures the impact effect of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions; $Control$ represents a series of control variables; $time$ represents time dummy variables; r_i represents policy dummy variables; and ε_{it} represents random disturbance terms, with β being coefficients to be estimated.

2.1.1 PSM Results

The results indicate that all treatment groups were matched with corresponding control groups, with no unmatched samples, which effectively helps address potential self-selection bias in test results.

2.1.2 Balance Test

After completing sample matching, a balance test is required to verify whether the samples meet data balance standards. When the standardized bias percentage for all variables remains within 5%, the matching results achieve an ideal

balance. According to the balance test results (Table 4), the absolute standardized bias values for all control variables after matching are below 5%, meeting the requirements. Additionally, t-test results for all variables after matching are below the critical value of 1.96, and P-values do not reach significant levels, meaning we do not reject the null hypothesis of no significant difference between treatment and control groups. Therefore, the matched samples show similarity in basic characteristics between control and treatment groups, indicating good matching quality.

2.1.3 Common Support Test

To more intuitively demonstrate the matching effect of PSM, based on the balance test, the kernel density of propensity scores for treatment and control groups before and after matching is compared using the nearest neighbor matching method (Figure 2). The results show that before propensity score matching, the probability distributions of propensity scores between treatment and control groups differed significantly; after matching, the propensity score probability density distributions of the two groups became consistent, the difference in probability distributions significantly narrowed, the overlapping area expanded substantially, and the number of matched samples within the common support range increased. This indicates good PSM matching effects, and the analysis results obtained using the PSM-DID method are reliable.

2.1.4 Parallel Trend Test

The main purpose of the parallel trend test is to assess whether treatment and control group samples have similar development trends before policy implementation, thereby excluding the possibility that policy effects are influenced by other unobserved factors and allowing continuation of the analysis. This study employs the event study method, selecting three years before policy implementation (2013–2015) and three years after (2017–2019) to estimate effects for each period. As shown in Figure 3, the dynamic policy effects for each period before 2016 fluctuate around 0 and are not significant, indicating that treatment and control groups had the same development trends before policy implementation, with non-significant differences, meeting the parallel trend assumption.

2.2 DID Regression Results

Based on data within the common support domain, STATA software is used to perform DID estimation on matched treatment and control groups after removing unmatched samples, yielding 1,540 sample observations to analyze the impact effect of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions. Column (1) in Table 5 shows test results without control variables but with time and policy fixed effects; Column (2) shows results with control variables and both time and policy fixed effects.

The study finds that after controlling for variables without considering time and policy fixed effects, the time-policy interaction term coefficient is negative; when considering time and policy fixed effects without control variables, the time-policy interaction term coefficient is significantly positive at the 1% level, indicating that territorial spatial ecological protection and restoration has a significant positive effect on economic development in poverty-alleviated regions. After controlling for both control variables and fixed effects, the time-policy interaction term regression coefficient is 0.0329, also significant at the 1% level. This indicates that, under otherwise unchanged conditions, the economy of poverty-alleviated counties implementing territorial spatial ecological protection and restoration increased significantly by 0.0329 compared to regions without such implementation. Overall, implementing territorial spatial ecological protection and restoration contributes to economic development in poverty-alleviated regions.

Regarding control variable estimation results, terrain relief has a significant negative effect on economic development at the 1% level; consumption capacity has a significant positive effect at the 5% level; financial risk, government size, industrial structure, total retail sales of consumer goods, and proportion of industrial output value to GDP do not show significant effects. This suggests that terrain relief significantly affects the improvement of economic development levels in poverty-alleviated regions, while increased consumption capacity does not promote economic development in these areas. Additionally, financial risk, government size, industrial structure, total retail sales, and industrial output proportion may not have reached the threshold to significantly impact economic development in poverty-alleviated counties. Meanwhile, rising financial risk and industrial structure upgrading may hinder economic development improvement, thus currently not showing clear positive effects.

2.3 Placebo Test

Considering that changes in economic growth in poverty-alleviated regions may be influenced by other policy factors, this study conducts placebo tests from two aspects to ensure robustness of baseline regression results.

First, drawing on Yang et al. [2023], a counterfactual framework is constructed by setting a virtual policy time, advancing the policy implementation time by three years (2013) for regression analysis. If the virtual DID model coefficient remains significantly positive at the 1% level, it would indicate that economic development improvements in poverty-alleviated regions are driven by other policy factors or uncertainties rather than solely by territorial spatial ecological protection and restoration policy implementation. If the virtual DID regression coefficient is not significant compared to the actual policy implementation year, it can be confirmed that economic development improvements result from the policy effect. Columns (1) and (2) in Table 6 respectively show regression results for virtual policy implementation times advanced by one and two years. The study finds that simulating policy implementation times yields virtual DID

regression coefficients that are not significant compared to the actual policy implementation year, indicating that economic development improvements in poverty-alleviated regions result from territorial spatial ecological protection and restoration policy implementation rather than other policy factors, confirming robust baseline regression results.

Second, based on Liu et al. [2022], some samples are randomly selected from the treatment group to be included in the control group, while some samples are randomly drawn from the control group to join the treatment group, constructing a virtual policy grouping. Using the study's model for 500 regression estimations, the distribution of virtual DID regression coefficients is obtained. As shown in Figure 4, the mean of the virtual DID regression coefficients is not significantly different from 0, indicating that randomly assigned virtual policy groupings do not produce significant effects of territorial spatial ecological protection and restoration on economic development in poverty-alleviated regions, further confirming that baseline regression results are robust.

2.4 Mechanism Analysis of Territorial Spatial Ecological Protection and Restoration's Impact on Economic Development in Poverty-Alleviated Regions

The "Shanshui Project" plays a demonstrative and leading role in national territorial spatial ecological protection and restoration, holding significant importance for ensuring national ecological security and improving regional ecosystem quality and function. The above research results indicate that implementing the "Shanshui Project" significantly promotes socio-economic development in China's poverty-alleviated regions. In fact, against the backdrop of rural revitalization, territorial spatial ecological protection and restoration work has a clear public value orientation, and the production and creation of public value in ecological protection and restoration will contribute to sustainable economic development in poverty-alleviated regions. Specifically, territorial spatial ecological protection and restoration projects represented by the "Shanshui Project" optimize territorial spatial patterns and enhance ecological product value while simultaneously conducting coordinated comprehensive remediation of multiple elements including "population, land, industry, property rights, and policy" in project implementation areas. Through approaches such as "ecological relocation," these projects enhance the sustainable development capacity of poverty-alleviated regions (Figure 5).

2.4.1 Ecological Compensation Ecologically fragile areas are typically gathering places for impoverished populations, and ecological compensation is an important means to achieve poverty alleviation goals. Since 2016, over 80% of the nation's afforestation and greening tasks in ecological protection and restoration have been arranged in poor areas, with 2.05 million ecological forest rangers cumulatively employed in poor areas, combining with other assistance measures to precisely lift 1.1 million impoverished people out of poverty and

increase their income. Ecological compensation guides local governments to strengthen ecological construction and improve living conditions and livelihood levels of rural poor populations by broadening income sources for farmers and herders and promoting reemployment of rural surplus labor, thereby driving regional economic growth.

2.4.2 Ecological Product Value Enhancement and Realization Ecological product value realization involves trading through existing or newly established transaction mechanisms to internalize externalities, representing a key process for transforming “green waters and mountains” into “golden mountains and silver mountains” in poverty-alleviated regions. Public ecological products such as water conservation and climate regulation provided by poverty-alleviated regions realize their value through vertical ecological compensation and inter-regional horizontal ecological compensation. Quasi-public ecological products represented by carbon sinks can be transformed by governments through legal or administrative controls on natural resources, ecological capacity, and ecological rights into standardized “quota” and “indicator” products that realize value through market transactions. Operational ecological products such as newly added farmland indicators after land consolidation and forest land use rights from water conservation projects can promote market-oriented operation of resource assets through transfer, lease, mortgage, and equity participation of land and forest rights, realizing ecological product value carried by natural resource assets. The enhancement of ecological product value and realization of its spillover effects through activating regional financial and industrial capital open new development models of “ecological protection and restoration + related industries,” promoting quality improvement and efficiency gains in related industries such as ecological agriculture and eco-tourism in poverty-alleviated regions.

2.4.3 Relocation for Poverty Alleviation As an important component of targeted poverty alleviation, relocation policies mainly include scattered resettlement and concentrated resettlement. Scattered resettlement in poverty-alleviated regions primarily relies on existing public infrastructure and vacant housing resources in resettlement areas, with local governments able to conduct resettlement through purchasing vacant housing and allocating farmland, while recipients can also choose to work in cities or rely on relatives and friends. Concentrated resettlement focuses on forming new industrial layouts, such as constructing residential communities around villages or county seats, with poor families moving into these communities. Relocation in poverty-alleviated regions must consider not only “moving out” but also ensuring “stability and prosperity.” Taking Jingle County in Shanxi Province as an example, with relevant policy support, the county actively developed traditional sauce and vinegar workshops in concentrated resettlement areas according to the “one village, one product” concept, while innovating farmer income increase benefit mechanisms and constructing “cooperative + farmer” interest linkage mechanisms

to ensure farmer income growth. For special poor groups such as the elderly, weak, sick, and disabled, the county provided support through minimum living allowances, pensions, subsidies for returning farmland to forests, photovoltaic power, and collective share dividends. The construction of “new villages” in poverty-alleviated regions and long-term livelihood security for farmers have realized the economic effects of population agglomeration in these areas.

3.1 Conclusions

- (1) From the perspective of effect measurement, compared with poverty-alleviated regions without territorial spatial ecological protection and restoration, the economic development rate of counties implementing such restoration increased significantly by 0.0329. This conclusion remains robust after balance tests, common support tests, parallel trend tests, and placebo tests.
- (2) From mechanism analysis, both short-term and long-term economic effects should be considered in implementing territorial spatial ecological protection and restoration. Realizing ecological product value is an important means of sustainably promoting economic development in poverty-alleviated regions. Based on improving relevant ecological product value realization systems, these regions should receive more policy support to facilitate the transformation of “green waters and mountains” into “golden mountains and silver mountains.”

3.2 Recommendations

- (1) Against the backdrop of rural revitalization, poverty-alleviated regions should, on the basis of making good use of policy funds, incentivize various social and industrial capitals to enter territorial spatial ecological protection and restoration through multiple channels, promoting environmental quality improvement and regional economic development. In territorial spatial ecological protection and restoration, measures such as work-relief programs can increase household income in the short term, while new development pathways such as quality improvement and efficiency gains in related industries are key to long-term transformation of “green waters and mountains” into “golden mountains and silver mountains.” Therefore, both short-term and long-term economic effects should be considered in implementing territorial spatial ecological protection and restoration, continuously exploring new pathways for increasing people’s income and comprehensively improving farmer income levels through multiple approaches.
- (2) Ecological product value realization is an important means of sustainably promoting rural revitalization in the new era. More policy support should be provided to poverty-alleviated regions based on improving relevant ecological product value realization systems. For example, improving national carbon sink trading systems, rural land three-right separation

systems, and forest land rights confirmation systems can provide a basic foundation for ecological product value realization in poverty-alleviated regions. Additionally, providing more preferential policies in vertical ecological compensation, horizontal ecological compensation, related industrial development, and social capital introduction can manifest the “ecological value” of territorial spatial ecological protection and restoration in poverty-alleviated regions and facilitate the transformation of this “ecological value” into “economic benefits,” continuously enhancing the “self-generating capacity” for economic development in these regions.

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Table 1

County Selection for the Treatment Group and Control Group

Table 2

Variable Definition and Descriptive Statistics

Table 3

Propensity Score Matching (PSM) Results

Table 4

PSM Balance Test Results

Table 5

DID Regression Results of the Impact of Territorial Spatial Ecological Protection and Restoration on the Economic Development of Poverty-Alleviated Regions

Table 6

Robustness Test Results

Figure 1 [Figure 1: see original paper]

Standardized Deviation Results

Figure 2 [Figure 2: see original paper]

Kernel Density Distribution of Propensity Scores

Figure 3 [Figure 3: see original paper]
Parallel Trend Test Results

Figure 4 [Figure 4: see original paper]
Distribution of Virtual DID Regression Coefficients

Figure 5 [Figure 5: see original paper]
Mechanism of the Impact of Territorial Spatial Ecological Protection and
Restoration on the Economic Development of Poverty-Alleviated Regions

Note: Figure translations are in progress. See original paper for figures.

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