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# Fiscal Decentralization and County Natural Poverty: A Multidimensional Study Based on a BP Neural Network

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**Abstract:** To achieve the goal of long-term stable poverty reduction, it is necessary to implement not only economic poverty reduction but also natural poverty reduction and formulate a green and sustainable economic growth pattern, and finance is an effective means to affect economic poverty reduction and natural poverty reduction. This paper innovatively calculates the natural poverty index of 1712 county administrative units in China based on BP neural network and combines relevant county data to investigate the impact of county fiscal decentralization on natural poverty and its transmission mechanism from 2000 to 2020 using a two-way fixed-effect model, which provides a new interpretation perspective for green economy patterns and sustainable development. The main research results are as follows: First, the increase in county-level financial autonomy in China significantly increases the level of regional natural poverty, which is still valid after a series of robustness tests using the instrumental variable method, replacing the response variables and processing with a one-stage lag. Secondly, heterogeneity analysis shows that, on the one hand, the positive impact of county-level fiscal decentralization on the natural poverty index is different in regions with different natural poverty formation mechanisms. On the other hand, the reform of "provincial direct management of counties" has significantly improved the natural poverty situation in counties, indicating that an extensive fiscal and taxation system in the early stages of economic development aggravates regional natural poverty and that optimized fiscal decentralization is conducive to the alleviation of natural poverty. Finally, the mechanism analysis found that the local income impact and expenditure preference accompanied by the fiscal decentralization of counties strengthened the race to the bottom of taxation, guided industrialization, hindered technological progress and led to the deterioration of regional natural poverty. This research claims that encouraging local governments to deepen and improve the fiscal decentralization system, implement the concept of green finance, improve the ecological protection compensation mechanism and market incentive system and implement differentiated mitigation plans for different natural poverty counties are the crucial factors to achieving natural poverty alleviation at the county level and improving regional ecological sustainability in the future.

**Keywords:** fiscal decentralization; natural poverty; green and sustainable development; BP neural network



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## 1. Introduction and Literature Review

Since the Industrial Revolution, the economies of all countries in the world have ushered in rapid development driven by the theory of "infinite growth", while the high consumption of natural resources and the destruction of the ecological environment have brought unprecedented survival pressure to human beings. The resource curse hypothesis has been repeatedly confirmed in the economic development process of some developing countries. It is obvious that poverty is multidimensional, and there is an important interactive relationship between ecological environmental poverty and regional economic poverty [1,2], which forces people to find a sustainable development path that is compatible

with economy, society and environment. The theory of sustainable development advocates mutually beneficial and coordinated development among human beings and between man and nature, while the phenomenon of natural poverty precisely represents the contradiction and conflict between people over the possession and distribution of ecological resources. Therefore, green development and natural poverty reduction are the premise and path to achieve the goal of sustainable development.

In recent years, the Chinese government has made remarkable achievements in poverty reduction. As the first developing country in the world to achieve the goal of halving the population living in poverty, the poverty alleviation system with Chinese characteristics has contributed to China's plan for the global poverty reduction project. However, the problem of long-term relative poverty still exists, and the deep poverty of regions is not only "deep" in economic and social dimensions but also reflects intensively in poor transportation infrastructure, inadequate public service supply, poor location, fragile ecological environment, etc. These noneconomic factors also profoundly impact the capability of vulnerable groups to overcome poverty [3]. Paying attention to the noneconomic poverty indicators represented by the natural poverty level, which is comprehensively measured by geographical characteristics, ecological environment and natural resources, is of great significance for realizing regional green and sustainable development and promoting poverty alleviation and rural revitalization in deeply impoverished areas.

Finance is an effective means to affect economic and natural poverty reduction. Many studies have carried out in-depth discussions on fiscal decentralization and poverty reduction. On the one hand, domestic and foreign research results on fiscal decentralization and economic poverty reduction are abundant and mainly formed the promotion theory and the inhibition theory. The promotion theory holds that fiscal decentralization will lead to healthy competition among local governments, bring about Pareto improvement in factor resource allocation and then promote the rapid development of the regional economy [4–9]. The inhibition theory holds that fiscal decentralization will lead to the misallocation of financial and administrative power, resulting in the alienation of local government behavior, resulting in efficiency loss, cliff-type and overdraft growth of regional economic development, thus inhibiting regional economic development [10–13]. In addition, some scholars believe that fiscal decentralization has diverse impacts on economic development, that is, decentralization from different perspectives will have different impacts on economic development and fiscal decentralization will have different impacts on different aspects of economic development [14–16]. On the other hand, from the perspective of green economy and sustainable development theory, some scholars have deeply explored the inter-relationship between fiscal decentralization and natural poverty reduction. Mainstream studies have shown that finance not only directly increases the level of regional haze pollution [17,18] and worsens local water quality [19], becoming a major determinant of hindering the process of natural poverty reduction [20,21], but also indirectly leads to the deterioration of ecological sustainable development through its impact on economic growth [22–25]. Some scholars also believe that the specific effects of fiscal decentralization on the ecological environment need to consider the asymmetric effects of fiscal decentralization [26]. Zheng Jie et al. (2020) used the provincial panel data of China from 1997 to 2016 to draw a conclusion that fiscal decentralization has different impacts on environmental governance at different stages of economic development [27]. It is believed that whether the impact of fiscal decentralization on environmental governance is dominated by the negative substitution effect or positive income effect depends on the process of regional economic development level. Rodden and Wibbels (2010) argued that due to the cyclical nature of fiscal system expenditure, the sustainability of the ecological environment may be more negatively influenced by fiscal decentralization than positively influenced [28].

A consensus has not been reached in the literature on the relationship between fiscal decentralization and poverty reduction, especially natural poverty reduction. At the same time, when studying the impact of fiscal decentralization on ecological environmental sustainability, scholars usually only select a single evaluation index, such as $CO_2$ emission,

$PM_{10}$, water quality and other indicators that can be directly obtained, and there is a lack of discussion on the correlation and mechanism between fiscal decentralization and the overall regional ecological environment and resources. Therefore, this paper focuses on the following two core missions: the construction of an overall natural poverty evaluation index in the region and the identification of the causal relationship and mechanism between fiscal decentralization and natural poverty.

Regarding the selection and construction of natural poverty indicators, Chen Nanyue (2003) described the formation mechanism of natural poverty from multiple dimensions, including insufficient land production capacity, a low level of natural ecological environment, poor living conditions of residents and increasing types of diseases [29]. Li Xunhuan et al. (2020) empirically assessed the level of natural poverty at the county level by using the BP neural network method from five regional dimensions, such as average altitude and surface fluctuation, but lacked the description of social characteristics in natural poverty [3]. Li Yihua and Li Jia (2022) defined the specific connotation of ecological burden and introduced it into the natural poverty index system, covering the relevant indicators of regional pollution emission and self-purification capacity and calculated using the A-F model [30]. This study provides a novel perspective on the measurement of natural poverty index and the analysis of its dynamic evolution. Based on the above studies, this paper further selected 11 indicators reflecting the county topography, natural resources and ecological vulnerability, comprehensively measured the ecological disadvantage of the county from three aspects, topography, natural resources and ecological burden, and used a BP neural network to build a multidimensional natural poverty evaluation system for the county. In an empirical study on fiscal decentralization and natural poverty, this paper selects the panel data of 1712 counties and county-level cities in China from 2000 to 2020 as a basis and adopts a two-way fixed effect model to evaluate the impact and mechanism of fiscal decentralization at the county level on natural poverty level to provide empirical facts for this paper.

The possible marginal contributions of this paper include: First, it broadens and improves the definition of natural poverty and related measurement indicators. In this paper, ecological burden indicators such as industrial discharge and environmental self-restoration ability and natural resource indicators such as arable land per person are introduced into the calculation system of natural poverty index. The inherent geographical ecological characteristics are integrated with social characteristics, which is conducive to describing the dynamic evolution of regional natural poverty under economic and social development and is closer to the causes of modern urban and rural natural poverty.

Secondly, this work improves the research framework of natural poverty. This paper applies the BP neural network method to the measurement of natural poverty and integrates the geographical definition and economic statistics measurement method to accurately measure the real level and formation mechanism of natural poverty in counties. At the same time, on this basis, this paper explores the impact of fiscal decentralization on natural poverty and describes natural poverty from the aspects of evaluation system, influencing factors and mechanism, which is different from previous studies that only measure the degree of natural poverty or focus on a single environmental indicator for causality inference.

Finally, this study selects 20 years during which China's fiscal decentralization system was continuously reformed and improved and the ecological environment and natural resources underwent great changes, to reveal the policy effect of China's county fiscal decentralization, the dynamic law of the structural change in the county natural poverty level and the evolution path more completely between the two. In the process of sample selection and data processing, remote sensing data ArcGIS software was used to cover most counties in the country, reduce data loss, fill the academic shortage of county-level data in current relevant studies and provide a reference for the targeted innovation of the fiscal decentralization system, promotion of green economy and promotion of ecological sustainable development.

## 2. Theoretical Framework and Research Hypothesis

### *2.1. Fiscal Decentralization and County Natural Poverty*

The issue of natural poverty in the county is a problem with the supply of public goods, where the supply side is the government and the demand side is the residents, i.e., the government provides the public goods of ecological environment and natural resources that meet the residents' requirements. Since most countries in the world have a multilevel system of government, the question of which level of government provides public goods involves the issue of decentralization versus centralization.

Classical decentralization theory, mainly based on the development status of the US federal government, suggests that local governments have a greater informational advantage and supply efficiency and is more sensitive to local demand preferences for public services. Meanwhile, constrained by the "vote with your feet" mechanism of residents in their jurisdictions, central and local governments need to seek equilibrium and avoid congestion effects [31,32]. However, fiscal federalism with specific Chinese characteristics based on the five-level government management system of "central–province–city–county–town" does not fully conform to the original decentralization theory, as local governments are subject to both fiscal decentralization and political centralization. Financial decentralization has played a key role in motivating local governments to maintain the market and promote economic growth, but local officials' assessment systems based on economic performance, which can be seen as a "promotion tournament" under political centralization, have made it difficult to establish a binding force for residents to move freely and "vote with their feet" in China's local development, and local governments have become a "reasonable person" pursuing their interests and pursuing tax revenues rather than residents' welfare [33]. In comparison with the classical decentralization theory drawn from the experience of developed countries, the second-generation decentralization theory proposed by observing the experience of developing countries is more compatible with the actual situation of county fiscal decentralization in China.

For developed countries, maximizing the social welfare of residents is an important factor in the objective function of local governments, and mechanisms such as information advantages formed by fiscal decentralization can be effectively exercised to benefit environmental governance as a whole, while for Chinese county governments, they assume almost all the functions and responsibilities of higher governments but lack the financial autonomy to match their powers and responsibilities [34]. However, the municipal government gives priority to the development of urban areas and has a serious squeeze on the county government's finances from the aspects of tax distribution, transfer payment and fund financing [35]. Economic growth takes a large proportion in the objective function of county government in China. Confronted with a short-term increase in fiscal autonomy, the rational choice of local governments is usually to prioritize economic development at the expense of environmental governance. Therefore, based on the characteristic Chinese fiscal decentralization system and the second-generation decentralization policy, Hypothesis 1 of this paper is proposed.

H1: Based on the development status of fiscal decentralization in China's counties, extensive fiscal decentralization will aggravate regional natural poverty.

### *2.2. Influential Mechanism of Fiscal Decentralization on County Natural Poverty*

The fiscal decentralization system determines the revenue and expenditure structure of local finance, which affects the efficiency of resource production and allocation of public goods [36], and the ecological environment, as a "soft" public good, can be influenced by the revenue and expenditure behavior of county governments. Hence, this paper proposes the transmission mechanism of fiscal decentralization affecting county natural poverty from two dimensions of the government's revenue and expenditure behavior under the fiscal decentralization policy.

2.2.1. The Effect of Tax Incentives of Fiscal Decentralization

A vast amount of the literature suggests that fiscal incentives are an important source of high economic and pollution growth in China [7,37]. The revenue-sharing reform accompanying the fiscal decentralization system has further increased the share of central revenue and reduced the size of local revenue, pushing an adjustment of the fiscal systems of local governments to alleviate revenue and tax pressure.

On the one hand, the fiscal decentralization system has brought tax incentives to local governments, and for most counties, the secondary industry, especially industry, is still the main tax source. Compared with the service industry, industry has lower requirements for economic development. Local governments can promote industrial development through various means, such as selling industrial land at low prices, developing infrastructure, financial support, etc. Industry provides sufficient conditions for local governments to deal with the upward shift in tax power. Industrial enterprises can not only bring a steady stream of VAT revenue but also have a strong spillover effect on the tertiary industry and business tax [38]. Therefore, local governments have sufficient incentives and conditions to promote industrial growth for tax base growth, and this industrial-scale expansion induced by tax incentives will eventually be intuitively reflected in local environmental quality and industrial pollution levels.

On the other hand, local governments promote economic growth in their regions by lowering environmental regulations to expand tax revenue, which indicates that economically lagging regions are more likely to sacrifice the environment to achieve goals such as attracting investment, increasing employment, and increasing tax revenue [39–41]. As the economic losses from capital outflows outweigh the gains from environmental improvements when labor is freely mobile, local governments will tend to impose lower levels of environmental standards to avoid capital shifts from their regions to areas with lax environmental regulations, reallocating spatially both pollution and environmentally clean industries efficiently, leading to inter-regional race to the bottom competition in environmental regulations [42]. Furthermore, because of the negative externalities of pollution and environmental spillover effect between regions, as the degree of the fiscal decentralization of local governments increases, so does the level of environmental pollution in their surrounding areas [43]. In summary, the revenue pressure from lower tax shares incentivizes county governments to expand local tax revenues, which directly leads to their commitment to developing industrial economies and lowering environmental regulations to expand the tax base, thereby impacting county ecology. Hence, Hypothesis 2a of this paper is proposed.

H2a: The county fiscal decentralization system will affect the degree of regional natural poverty through tax incentive effects.

2.2.2. The Effect of Expenditure Preference of Fiscal Decentralization

Under fiscal decentralization and political centralization, the structure of local government expenditure is distorted, which is manifested in the emphasis on infrastructure construction and the neglect of public service capabilities such as human capital investment [44]. During their tenure, local officials are more enthusiastic about repeated investments in "political achievement projects" and less interested in "soft" public goods such as the environment. Fiscal decentralization has significantly increased the share of basic expenditures and reduced the share of livelihood services [45].

According to the relevant literature, how county government expenditure distortions affect regional natural poverty can be classified as composition effects and technology effects. Composition effects indicate that production activities under the specific economic structure of the society have different pollution emission intensities, which affects the regional natural environment [46], and that environmental quality decreases and then improves when the industrial structure shifts from agriculture to industry and then to services; the technology effect mainly refers to the progress of clean production technology and pollution control technology, that is, a series of technological advances which affects the re-

gional environment. Since local governments in China have the power to control resources in the areas under their jurisdiction and have a strong influence on local development, under the competition for performance caused by the fiscal decentralization system, county governments' fiscal expenditures prefer traditional basic industries to the construction of clean industries such as service industries and the supply of livelihood public goods such as human capital investment. The distorted expenditure structure suppresses the upgrading of the county's industrial structure and technological advancement and further affects local ecological and environmental resources. Consequently, based on the arguments above, Hypothesis 2b of this paper is proposed.

H2b: The county fiscal decentralization system will affect the degree of regional natural poverty through composition effects and technology effects.

## 3. Construction and Measurement of County NPI

### *3.1. Evaluation System and Data Source*

#### 3.1.1. Formation Mechanism of Natural Poverty

Natural poverty is the poverty caused by an insufficient supply of regional ecological resources, including a lack of resource endowment and the destruction of resources caused by human activities. Therefore, the concept of ecological burden is introduced in this paper to define and measure the impact of social and economic activities on ecological sustainability. On the one hand, social activities have a burden on the environment through pollutant discharge and other ways; on the other hand, the self-purification and restoration ability of ecosystem also has a positive effect on ecological burden. By introducing the index of ecological burden into the evaluation system, the actual explanation of natural poverty can be strengthened under the background of the expansion of economic activities.

Based on the formation mechanism of natural poverty, this paper summarizes it as three forming paths: extreme topography, lack of natural resources and excessive ecological burden. First, for natural poverty areas with extreme topography and remote locations, harsh climate and poor soil conditions lead to greater difficulties in agricultural production and infrastructure construction, and it is easy to form a relatively closed social environment, restricting local economic development and residents' production and life. Secondly, for natural poverty areas with insufficient natural resources, the development of the primary industry will be restricted due to the lack of raw materials, resulting in an increase in economic development costs. Based on the environmental reliance poverty trap theory, a poor economic development foundation will further stimulate the destructive plunder of the environment, induce local economic development at the expense of resources and environment and force it into a vicious circle of "plunder-development-plunder". Third, for natural poverty areas with heavy ecological burden, pollution emissions caused by economic development that exceed the regional ecological recovery capacity will have a direct impact on residents' quality of life, reduce local labor productivity and human capital accumulation, inhibit economic and social development and lead to a vicious circle of "pollution-development-pollution" in the region.

#### 3.1.2. Construction of Natural Poverty Evaluation System

Based on the formation mechanism of natural poverty, this paper constructs a multidimensional evaluation system of natural poverty at the county level from three dimensions: extreme topography, shortage of natural resources and ecological burden. It includes three dimensions and 11 secondary-level indicators which comprehensively reflect the degree of natural poverty at the county scale, taking counties as spatial units in geography. First, the measurement of ecological burden is the core of the natural poverty index system. According to the definition of ecological burden and the availability of data, it is divided into two negative and positive directions, with a total of three indicators: the first two are negative indicators, namely $PM_{2.5}$ pollution and $CO_2$ emission per person, to measure the adverse impact of human economic activities on regional ecological environment. The environmental purification values of terrestrial ecosystems are used as positive indicators

to reflect the ecological self-purification capacities of different regions. The higher the value, the stronger the regional ecological environment self-purification capacity and the stronger the carrying capacity for environmental damage caused by economic activities. If the negative indicator is regarded as the ecological burden of a certain region, then the positive indicator is the ecological advantage of the region. Therefore, these three indicators can fully present the mechanism of the ecological burden. Secondly, in the dimension of topography, this paper selects four indexes: elevation, elevation range, ground slope and percentage of surface with slope angle above 25°. Among them, elevation and ground slope, respectively, measured the basic terrain and landform of the region. The higher the altitude, the greater the slope, the stronger the hindrance to economic activities. Elevation range and the percentage of surface with a slope angle above 25° can more accurately measure the distribution of the land suitable for the development of the primary and secondary industries in the region. Finally, in the dimension of natural resources, this paper selects four indicators: precipitation, vegetation index, drainage density and arable land per person. The precipitation, vegetation index and drainage density measure the natural conditions and climate environment of the region, and the arable land per person mainly reflects the development potential of the region's primary industry. All indicators are explained in Table 1.

**Table 1.** County natural poverty evaluation system.

| Indicator Dimension | Serial Number | Indicators | Meaning of Indicator |
|---|---|---|---|
| Topography | $X_1$ | Elevation (m) | Average DEM elevation |
| | $X_2$ | Elevation range (m) | DEM elevation range |
| | $X_3$ | Ground slope | Average DEM slope angle |
| | $X_4$ | Percentage of surface with slope angle above 25° (%) | Percentage of land area with slope angle above 25° |
| Natural resources | $X_5$ | Precipitation (mm) | Average precipitation |
| | $X_6$ | Vegetation index | Normalized difference vegetation index |
| | $X_7$ | Drainage density (km/km$^2$) | Average DEM drainage density of major rivers |
| Ecological burden | $X_8$ | Arable land per person (m$^2$) | Total area of arable land per habitant |
| | $X_9$ | $PM_{2.5}$ pollution (μg/m$^3$) | Mean concentration of $PM_{2.5}$ |
| | $X_{10}$ | $CO_2$ emission per person (t) | Annual $CO_2$ emission per habitant |
| | $X_{11}$ | Environmental purification values of terrestrial ecosystems (yuan/hm$^2$) | Average environmental purification values of terrestrial ecosystems |

In this paper, the ground slope, elevation and elevation range data adopted in the evaluation system of county natural poverty indicators are derived from 30 m resolution DEM data of a geospatial data cloud. ArcGIS10.8 software is used to extract and calculate the mean value of county-level data points. The percentage of surfaces with slope angles above 25° in each county are extracted after reclassifying the slope in the DEM database. The land use remote sensing images, the NDVI 250 m resolution raster dataset from 2000 to 2020, the DEM-extracted dataset of the distribution of major rivers in China and the dataset of the spatial distribution of the environmental purification values of terrestrial ecosystems in China are all obtained from the RESDC, and the data are extracted and averaged based on county-level data in ArcGIS 10.8 software. The precipitation data from 2000 to 2019 are based on the CMDC Terrestrial Climate Data Daily Value Dataset, and the precipitation data in 2020 are derived via linear interpolation. The 2000–2017 county $CO_2$ emission data are obtained from the CEADs, and county $CO_2$ emission data for 2018–2020 are derived using the linear interpolation method. The 2000–2020 county $PM_{2.5}$ mean concentration data are obtained from the University of Washington Atmospheric Composition Analysis Group. Due to the lack of data sources in some years, this paper uses the linear interpolation method to calculate and complete the data of existing years. Since the relevant index data

of topography do not change significantly over time, this paper uses the latest year's data of 2020 to ensure measurement accuracy.

### *3.2. Measurement Procedures*

The evaluation of multidimensional natural poverty at the county level needs to consider the complex relationship between each dimension and index and how to determine the function of each index, in which the weight is the focus of the evaluation system. As a multilayer feedforward neural network which can realize error backpropagation and weight correction, a backpropagation neural network (BP neural network) provides objective and feasible conditions for the simulation and evaluation of regional natural poverty degree.

A BP neural network is a kind of multilayer feedforward neural network, which is composed of one input layer, one or more hidden layers and one output layer. A BP neural network generally includes two stages: the training stage and prediction stage. The working principle is as follows: In forward transmission, the input signal is processed layer by layer until the output layer. If the output result is different from the expected output, it will be backpropagated, and the weight and threshold will be adjusted according to the prediction error, so that the predicted output value is constantly approaching the expected output value. After repeated learning and training, the minimum error sum of squares and corresponding network parameters (weight value and threshold value) are obtained, and the training phase is terminated. Then, we enter the prediction stage, that is, we input similar prediction samples to the trained network model, and the network will output the corresponding result with the least error. The specific action mechanism of the BP neural network model is shown in Figure 1.

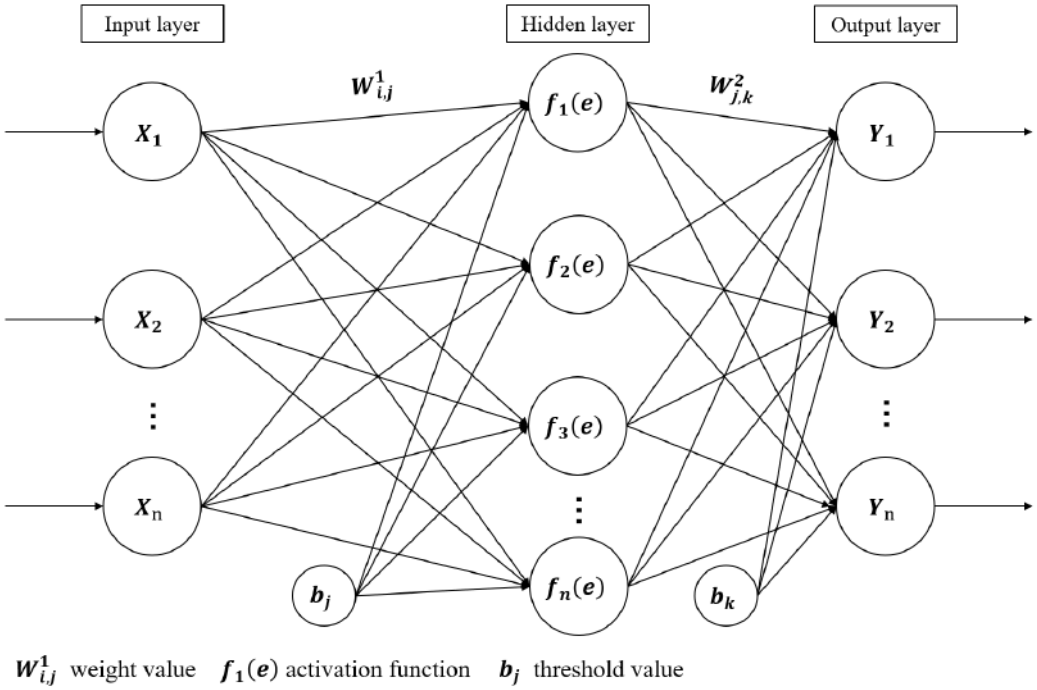


**Figure 1.** BP neural network working mechanism.

A BP neural network has the advantages of simple construction and rich training algorithms, is applicable in simulation, evaluation, prediction and forecast and classification and is widely used in artificial neural network technology. In this study, a BP neural network model for county multidimensional cultural poverty evaluation is constructed based on MatlabR2017, the steps of which are as follows:

3.2.1. Construction of BP Network Model

In this paper, a three-layer neural network with one input layer, one hidden layer and one output layer is constructed. The number of neurons in the input layer is determined by the number of indicators; the number of neurons in the output layer is the single-dimensional natural poverty index, in which the number of neurons is 1. The number of neurons in the hidden layer is determined by the golden mean method, i.e., Equation (1), and on the premise of meeting the learning accuracy, the training times should be as small as possible. In the equation, m is the number of nodes in the hidden layer, n is the number of nodes in the input layer, l is the number of nodes in the output layer and $\alpha$ is a constant between 1 and 10. Through multiple trials, the numbers of hidden layer nodes in the estimation process were finally determined to be 11, 9 and 5 for the indicators of topography, natural resource and ecological burden, and their network structures are 4 × 11 × 1, 4 × 9 × 1 and 3 × 5 × 1, respectively. The network parameters settings are as follows: the transfer function of the hidden layer is Tansig, the transfer function of the output layer is Purelin, the learning function is Learngdm and the performance function is mean square error (MSE).

$$m = \sqrt{(n+l)} + \alpha \quad (1)$$

3.2.2. Neural Network Training

County multidimensional natural poverty measurement is the neural network fitting problem in which the network training data generally consist of national or local determined standards, such as national or local standards for water and air quality. Due to the county natural poverty measurement having not yet formed a common evaluation standard, there are no existing rating criteria for setting network training data. Therefore, this article uses the Jenks classification method to determine the data cut points, and the critical values represented by the five tangent points are set in order of 1–5; then, it uses the Spline function for linear interpolation to expand the sample size in the construction of the BP neural network training data. Thus, the specific evaluation criteria for the measurement of natural poverty indicators in this paper are obtained. Each critical value and the level settings of secondary indicators are shown in Table 2. The network training parameter settings are as follows: the training function is Trainlm, the maximum number of iterations is 10,000, the maximum error is 0.00001, and default values are taken in other parameters.

**Table 2.** Evaluation standards of BP network in county natural poverty measurement.

| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | Scale |
|---|---|---|---|---|---|
| Topography | 0.0662 | 0.0869 | 0.1077 | 0.0616 | 1 |
| | 0.1825 | 0.1971 | 0.2683 | 0.1819 | 2 |
| | 0.3452 | 0.3409 | 0.4349 | 0.3572 | 3 |
| | 0.5989 | 0.5697 | 0.6225 | 0.6399 | 4 |
| | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 5 |
| | $X_5$ | $X_6$ | $X_7$ | $X_8$ | Scale |
| Natural sources | 0.5229 | 0.1647 | 0.0000 | 0.4549 | 1 |
| | 0.6438 | 0.2890 | 0.7079 | 0.7172 | 2 |
| | 0.7483 | 0.4677 | 0.9245 | 0.8720 | 3 |
| | 0.8417 | 0.7036 | 0.9697 | 0.9524 | 4 |
| | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 5 |
| | $X_9$ | $X_{10}$ | $X_{11}$ | Scale | |
| Ecological burden | 0.1860 | 0.0206 | 0.6349 | 1 | |
| | 0.2769 | 0.0625 | 0.8550 | 2 | |
| | 0.3746 | 0.1660 | 0.9288 | 3 | |
| | 0.5054 | 0.4464 | 0.9708 | 4 | |
| | 1.0000 | 1.0000 | 1.0000 | 5 | |

3.2.3. Simulation Results

To eliminate the influence of the different statistical units of the indicators and to distinguish positive and negative indicators, this article classified and normalized positive and negative indicators of 11 secondary indicators according to the method of range standardization. The processing formula is shown in Equations (2) and (3). The normalized sample data are input into the trained BP neural network, the Sim function is selected to obtain the topography index, natural resources index and ecological burden index for each county, and the summation is performed to calculate the county multidimensional natural poverty index (NPI).

$$A_{tj} = \frac{X_{tj} - \min(X_t)}{\max(X_t) - \min(X_t)} (X_t \text{ as positive}) \quad (2)$$

$$A_{tj} = \frac{\max(X_t) - X_{tj}}{\max(X_t) - \min(X_t)} (X_t \text{ as negative}) \quad (3)$$

*3.3. Measurement Results Analysis*

3.3.1. Spatial Distribution and Dynamic Change in NPI at County Level

Based on the measurement results of the BP neural network model, this paper uses ArcGIS software to obtain the grade distribution of the comprehensive natural poverty level of 1712 counties from 2000 to 2020, as shown in Figure 2. From the perspective of spatial distribution, there are significant regional differences in natural poverty in China. Severe and extreme natural poverty counties are mainly distributed in the western region, including Xinjiang, Qinghai, Gansu and other regions, and most of the extreme natural poverty counties are distributed here. The mild and moderate natural poverty counties are mainly distributed in the central and eastern regions, and most non-natural poverty counties are also concentrated here. From 2000 to 2020, the level of natural poverty in all regions showed a downward trend, and some counties realized the level from severe to moderate and from mild to non-natural poverty. However, the spatial distribution pattern of natural poverty in China did not change significantly in the time dimension, which was mainly affected by the topography and distribution of natural resources. As a result of China's "three ranks" geographical pattern, plateau and mountain areas are concentrated in the western region, where natural resources are relatively scarce, farmland productivity and forest coverage rate are relatively low, weak economic development foundation makes these areas more likely to develop at the expense of the environment and overloaded social and economic activities lead to high ecological burden. As a result, the severe and extreme natural poverty counties dominate. On the contrary, the central and eastern regions are mostly plains and hills; among which, northeastern and northern China are rich in forest resources, while southern China is rich in water resources, which means great potential for farmland production and stronger ecological self-purification capacity, which can endure more ecological burdens. Therefore, non-natural poverty counties and mild natural poverty counties mainly exist in this region.

The average natural poverty index of China's counties and the changes in each dimension index from 2000 to 2020 are shown in Figure 3. Judging from the change in natural poverty index, China's natural poverty has experienced a process of overall decline and local increase. From 2000 to 2005, the natural poverty index (NPI) showed a rapid decline. Since then, the NPI rose from 6.313 in 2006 to 6.353 in 2009, after which it slowly declined to 6.126 by 2020. The change in the natural resource poverty index is very similar to the change in the natural poverty index, with the highest values occurring in 2003, 2009 and 2014, which is exactly consistent with the change in the NPI trend. On the contrary, the poverty index of the ecological burden dimension did not change much between 2000 and 2020, with a maximum value in 2015 (2.817) and a minimum value in 2006 (2.772), which is significantly different from the change trend of the NPI.

The number of natural poverty counties showed an overall trend of moderate and severe decrease and slight increase. The change in natural poverty is mainly related to the change in ecological burden and natural resources. From 2000 to 2020, China's industrialization has experienced a process from rapid expansion to gradual focus on green and sustainable development. During this period, the quality of the ecological environment across the country continuously improved and the ecological conditions of counties gradually improved, among which the number of mild natural poverty counties increased from 692 in 2000 to 847 in 2020, while the number of moderate natural poverty counties decreased from 690 in 2000 to 584 in 2020. This change is mainly distributed in northeastern, central and southern China, which rely on relatively good ecological foundations. After 20 years of in-depth sustainable development policy and environmental governance, they finally improved into mild natural poverty areas. From the perspective of severe and extreme natural poverty counties, in 2000, the number of severe natural poverty counties was 233 and the number of extreme natural poverty counties was 57, while in 2020, the number of severe natural poverty counties was reduced to 152 and the number of extreme natural poverty counties was also reduced to 46.

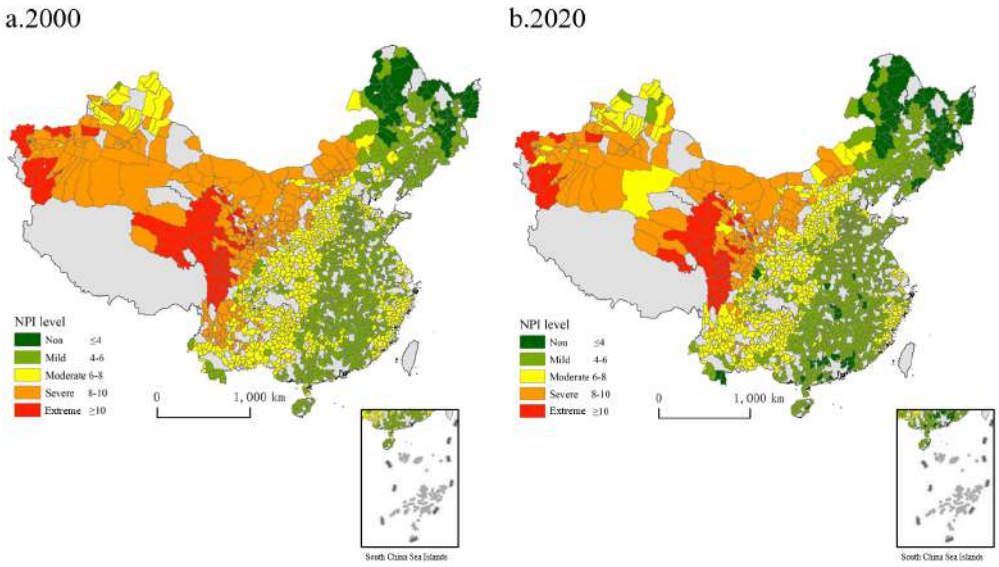


**Figure 2.** Spatial distribution of NPI at county level in China.

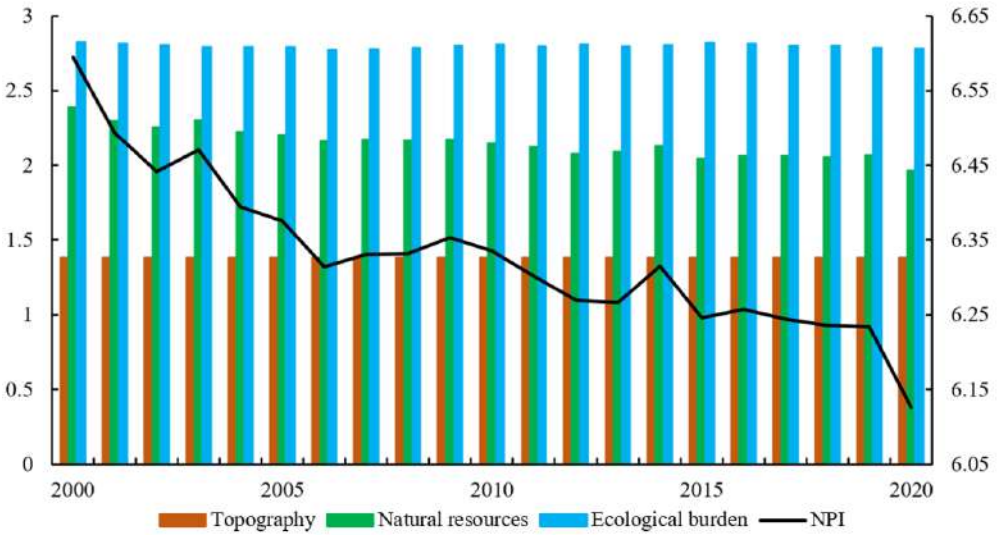


**Figure 3.** Change trend of NPI and dimensional index at county level in China.

3.3.2. Natural Poverty Structure at County Level

Figure 4 depicts the change in the number proportion of different types of natural poverty counties from 2000 to 2020. The main type of natural poverty in China is ecological burden. After 2000, due to the rapid expansion of China's industry at the expense of the environment, the number of poor counties with ecological burden began to rise, and the proportion reached 78.5% in 2015, becoming the highest value in history. Since 2015, with the implementation of the concept of sustainable development and the focus on pollution emission control and ecological environment governance, the proportion of poor counties with ecological burden decreased to 76.5% in 2020, but it is still the largest type of natural poverty, which fully demonstrates the necessity of introducing the concept of ecological burden into the natural poverty evaluation system.

From the spatial distribution changes in different types of natural poverty counties, as shown in Figure 5, their geographical distribution did not change significantly in the time dimension. Among them, the distribution in southwestern China is mainly topography natural poverty. For example, Yunnan, Guizhou, Sichuan, Qinghai and other areas close to the Qinghai–Tibet Plateau have increased mountainous areas and large fluctuations, which make it difficult to build regional transportation and infrastructure, hinder economic and social development and become a typical representative of topographic poverty. Natural poverty based on natural resources is mainly distributed in northwestern China, with representative provinces such as Xinjiang, Gansu, Shanxi and Inner Mongolia. The natural poverty in this region is reflected in the lack of cultivated land, water, forest and other resources, which is not conducive to the development of the primary industry. Natural poverty with ecological burden is most widely distributed and covers the largest area, including most of northern, eastern and southern China. These areas have a high degree of industrial development and a concentration of energy enterprises, resulting in excessive emissions of pollutants in the region, affecting the health of residents and then affecting economic and social development.

In terms of the number of different types of natural poverty counties, the number of topography increased from 67 in 2000 to 108 in 2020, the number of natural resources decreased from 530 in 2000 to 294 in 2020, and the number of ecological burdens increased from 1155 in 2000 to 1310 in 2020. This shows that with continuous improvement in China's environmental governance level, the natural poverty caused by natural resources gradually weakened. On the other hand, the environmental pollution accompanied by an improvement in industrialization level increased the proportion of ecological burden affecting natural poverty, resulting in an increase in the number of ecological burden types and becoming the primary factor affecting the level of natural poverty.

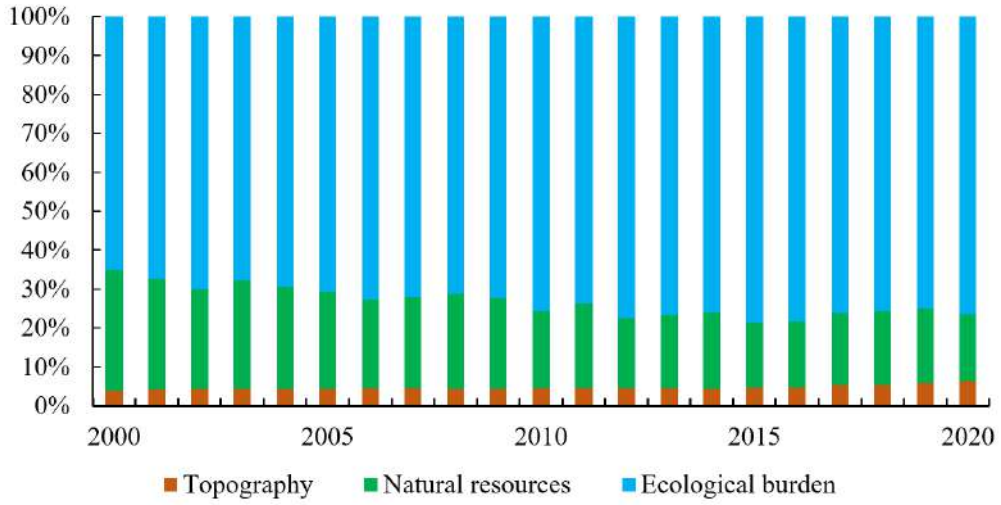


**Figure 4.** Proportion of different types of natural poverty at county level in China.

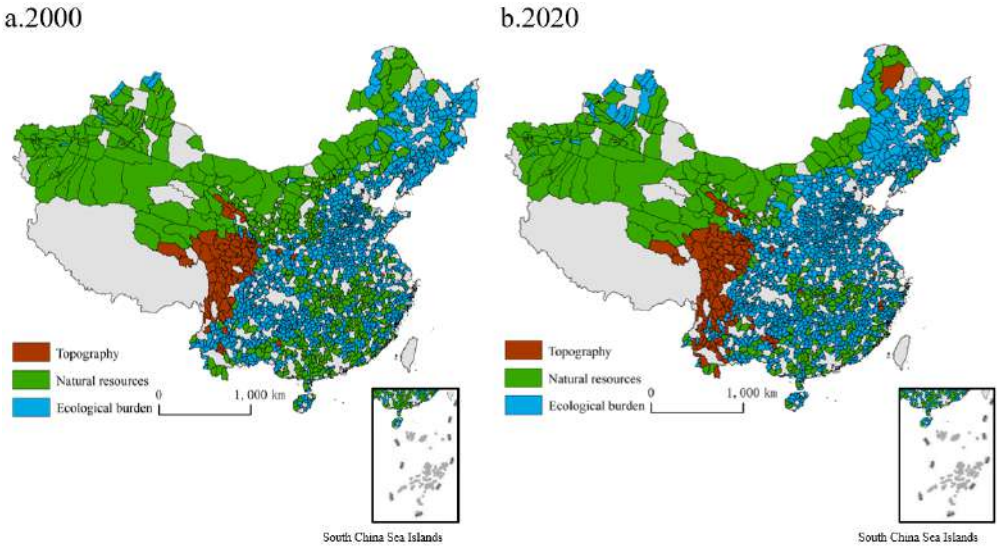


**Figure 5.** Spatial distribution of different types of natural poverty at county level in China.

## 4. Empirical Strategy and Data Description

### *4.1. Model Specification and Identification*

A two-way fixed effects regression equation (as in Equation (4)) is used as the baseline model to analyze the impact of fiscal decentralization on county natural poverty:

$$NPI_{ct} = \alpha + \beta finance_{ct} + \theta X_{ct} + \varphi_c + year_t + \varepsilon_{ct} \quad (4)$$

where subscripts c and t denote county and year, respectively; the response variable is the natural poverty index while the core explanatory variable $finance_{ct}$ indicates the degree of fiscal decentralization; $X_{ct}$ contains a set of vectors of county-level control variables to control for county characteristics and $\varphi_c$, $year_t$ and $\varepsilon_{ct}$ denote, respectively, county fixed effect, year fixed effect and random interference term. The coefficient $\beta$ is the effect of the degree of fiscal decentralization on county natural poverty under multidimensional measurements.

### *4.2. Variable Definitions*

The response variable in this paper is the county comprehensive natural poverty index (NPI) calculated using a BP neural network (see Section 3). The explanatory variable and other relevant variables are selected as follows.

#### 4.2.1. Core Explanatory Variable: Fiscal Decentralization

The existing studies on the degree of fiscal decentralization can be categorized into three types: fiscal autonomy index, expenditure index and income index. Fiscal decentralization has a multidimensional meaning, and the logic and mechanism behind these three indicators are not identical [36].

(1) County fiscal autonomy = county general budget revenue/county general budget expenditure. This decentralization indicator measures the ability of local governments to rely on their revenues to finance their expenditures. General fiscal decentralization theory assumes that the greater the capability of local governments to raise revenue from their tax base, the greater their accountability to citizens. Conversely, the more financially dependent on other nonlocal revenue sources such as transfers and borrowing, the less accountability it has to its citizens. However, since the appointment and appraisal of local officials in China are made by higher levels of government, the above theory of local governments relying on tax revenues and being accountable to residents can hardly be fully applied in China, but the share of local revenues in local general expenditures still reflects the state of local financial autonomy to some extent.

(2) Degree of fiscal revenue (expenditure) decentralization = county-level budget revenue (expenditure)/affiliated municipal budget revenue (expenditure). Both county-level revenue (expenditure) decentralization measures reflect the size of the county government's resource holdings concerning the municipality to which it belongs, the difference being that the former reflects the size of the county's financial resources within the budget, while the latter reflects the handling of intergovernmental transfer funds. For counties belonging to the same municipality, the revenue and expenditure indicators only reflect intertemporal changes in fiscal relations between counties and municipalities, but not regional differences: county administrative units belonging to the same municipality all face the same denominator at the same point in time, which is the common municipal financial revenue (expenditure) information. The cross-sectional variation information of the degree of decentralization comes entirely from the numerator, which measures only the relative sizes of fiscal revenues (expenditures) of different counties under the jurisdiction of the same municipality but cannot fully reflect the cross-sectional information of the degree of fiscal decentralization across regions.

It is indicated from the above analysis that no single indicator of revenue and expenditure can capture the decentralization information of multiple dimensions of fiscal decentralization, so this paper measures the degree of fiscal decentralization in counties from three dimensions simultaneously: county-level fiscal autonomy, county-level general budget revenue decentralization degree and county-level general budget expenditure decentralization degree (see Table 3) to ensure the accuracy and robustness of the empirical findings.

**Table 3.** Multidimensional indicators of fiscal decentralization.

| Indicator | Meaning |
| --- | --- |
| Fiscal autonomy (finance1) | County general budget revenue/county general budget expenditure |
| General budget revenue decentralization degree (finance2) | County general budget revenue/affiliated municipal budget revenue |
| General budget expenditure decentralization degree (finance3) | County general budget expenditure/affiliated municipal budget expenditure |

#### 4.2.2. Mechanism Variables

Based on the mechanism hypotheses presented in the above theoretical analysis, three types of mechanisms (four variables in total) are selected in this study: the effect of tax incentives, the composition effect and the technology effect. The tax effect is articulated in terms of standardized tax revenue per capita per year in the county ($\ln perTax$), the composition effect is in terms of the proportion of value added in the secondary and tertiary industry to GDP (*industry2, industry3*), and the technology effect is indirectly measured in terms of the proportion of secondary school students in the total population (*STUDENT*) due to the lack of indicators to measure technology variables at the county level, owing to human capital as the carrier of knowledge and the source of technological progress.

#### 4.2.3. Control Variables

To control the effects of other variables on natural poverty at the county level, this paper introduces the following control variables: industrial structure, population density, education level, per capita income and public goods supply. The population density is calculated via the logarithm of the ratio of the total population to the area of the jurisdiction at the end of the year in each region ($\ln population$); education level is estimated via the logarithm of the number of students enrolled in primary and secondary schools ($\ln student1$, $\ln student2$); per capita income via the logarithm of the real GDP per capita and its square in each region ($\ln GDP$, $\ln GDP^2$); industrial structure via the logarithm of the share of secondary industry value added to GDP (*industry2*) and the number of industrial enterprises

(ln *enterprise*); while public goods are supplied via the logarithm of the number of beds in regional hospitals and health centers (ln *hospital*).

### *4.3. Data Source and Description*

This paper covers 1712 counties and county-level cities in 27 provinces from 2000 to 2020, excluding Hong Kong, Macao, Taiwan and four municipalities of China. In addition to the sources of data related to the construction of natural poverty indicators introduced in Section 3, the socioeconomic statistical data involved in the core explanatory variables and control variables in this paper are all from the China County Statistical Yearbook, and some missing values are supplemented by linear interpolation. The descriptive statistics of the variables are shown in Table 4.

**Table 4.** Descriptive statistics of variables.

| Variables | N | Mean | sd | Min | p50 | Max |
|---|---|---|---|---|---|---|
| NPI | 34,833 | 6.2883 | 1.5121 | 2.8652 | 5.9433 | 11.5215 |
| $NPI_1$ | 34,833 | 0.4908 | 0.2259 | 0.2085 | 0.4199 | 1.3003 |
| finance1 | 34,833 | 0.3254 | 0.2172 | 0.0269 | 0.2715 | 1.0054 |
| finance2 | 27,784 | 0.0989 | 0.1092 | 0.0046 | 0.0663 | 0.7129 |
| finance3 | 27,779 | 0.1196 | 0.1115 | 0.0163 | 0.0874 | 0.7433 |
| iv_finance1 | 34,701 | 0.3588 | 0.2011 | 0.0511 | 0.3096 | 1.0223 |
| iv_finance2 | 27,695 | 0.1060 | 0.1048 | 0.0134 | 0.0782 | 0.7425 |
| iv_finance3 | 27,689 | 0.1184 | 0.1112 | 0.0275 | 0.0860 | 0.7701 |
| ln *GDP* | 34,833 | 7.6166 | 0.8808 | 5.7169 | 7.5700 | 9.9047 |
| ln $GDP^2$ | 34,833 | 58.7883 | 13.6414 | 32.6828 | 57.3052 | 98.1024 |
| ln *population* | 34,833 | 5.1076 | 1.2793 | 0.6389 | 5.2513 | 7.0698 |
| ln *enterprise* | 34,833 | 3.6508 | 1.2843 | 0.6931 | 3.6636 | 6.6619 |
| ln *student*1 | 34,833 | 10.2248 | 0.8676 | 7.7084 | 10.2863 | 12.0054 |
| ln *student*2 | 34,833 | 9.8351 | 0.9215 | 6.7968 | 9.9282 | 11.5359 |
| ln *hospital* | 34,833 | 6.8393 | 0.8562 | 4.5850 | 6.8565 | 8.6911 |
| industry2 | 34,833 | 0.3977 | 0.1548 | 0.0861 | 0.3925 | 0.7778 |
| industry3 | 34,832 | 0.3532 | 0.1009 | 0.1421 | 0.3431 | 0.6532 |
| STUDENT | 33,601 | 5.4364 | 1.6800 | 1.6369 | 5.3343 | 9.9639 |
| ln *perTax* | 11,366 | 6.8623 | 1.1639 | 0.2877 | 6.8864 | 11.1263 |

## 5. Empirical Analysis and Discussion

### *5.1. Hausman Test*

Table 5 reports the baseline regression results and Hausman test results of the impact of fiscal decentralization on county natural poverty under the random effects model and the fixed effects model. Columns (1) to (3) are the regression results of the random effects model after adding control variables, and columns (4) to (6) are the regression results of the fixed effects model after adding control variables. The results show that county fiscal decentralization measured via county-level fiscal autonomy and county-level general budget revenue (expenditure) decentralization has a positive impact on local natural poverty index. The result is significantly positive at the 1% level. Moreover, the Hausman test results of the regression model based on the three indicators of county-level financial autonomy and county-level general budget revenue (expenditure) decentralization, respectively, have Prob>chi2 (*p*-value) equal to 0.000, which means that the null hypothesis of random effects is significantly rejected at the 1% level and the fixed effect regression model should be chosen. Therefore, in the subsequent regression, this paper will use a two-way fixed effect model for empirical analysis.

**Table 5.** Hausman test of fiscal decentralization on the natural poverty index.

| Variables | (1) RE | (2) RE | (3) RE | (4) FE | (5) FE | (6) FE |
|---|---|---|---|---|---|---|
| finance1 | 0.196 *** | | | 0.203 *** | | |
| | (0.009) | | | (0.009) | | |
| finance2 | | 0.107 *** | | | 0.107 *** | |
| | | (0.014) | | | (0.014) | |
| finance3 | | | 0.104 *** | | | 0.103 *** |
| | | | (0.013) | | | (0.013) |
| ln *population* | −0.063 *** | 0.002 | 0.002 | 0.077 *** | 0.069 *** | 0.069 *** |
| | (0.011) | (0.013) | (0.013) | (0.012) | (0.014) | (0.014) |
| ln *GDP* | −1.092 *** | −1.216 *** | −1.217 *** | −1.033 *** | −1.184 *** | −1.186 *** |
| | (0.028) | (0.032) | (0.032) | (0.027) | (0.031) | (0.031) |
| ln $GDP^2$ | 0.059 *** | 0.065 *** | 0.065 *** | 0.054 *** | 0.063 *** | 0.063 *** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| industry2 | 0.042 *** | 0.062 *** | 0.068 *** | 0.044 *** | 0.056 *** | 0.062 *** |
| | (0.013) | (0.015) | (0.015) | (0.013) | (0.015) | (0.015) |
| ln *enterprise* | 0.009 *** | 0.015 *** | 0.015 *** | 0.015 *** | 0.019 *** | 0.018 *** |
| | (0.002) | (0.003) | (0.003) | (0.002) | (0.003) | (0.003) |
| ln *student*1 | 0.079 *** | 0.087 *** | 0.086 *** | 0.076 *** | 0.088 *** | 0.087 *** |
| | (0.005) | (0.006) | (0.006) | (0.005) | (0.006) | (0.006) |
| ln *student*2 | −0.064 *** | −0.068 *** | −0.067 *** | −0.064 *** | −0.066 *** | −0.065 *** |
| | (0.004) | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) |
| ln *hospital* | −0.023 *** | −0.005 | −0.005 | −0.017 *** | −0.001 | −0.001 |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| Constant | 11.387 *** | 11.117 *** | 11.113 *** | 10.419 *** | 10.541 *** | 10.537 *** |
| | (0.138) | (0.164) | (0.163) | (0.137) | (0.166) | (0.166) |
| Observations | 34,833 | 27,784 | 27,779 | 34,833 | 27,784 | 27,779 |
| $R^2$ | | | | 0.282 | 0.250 | 0.250 |
| Hausman | | | | 1167 | 463.8 | 463.5 |
| *p*-value | | | | 0.000 | 0.000 | 0.000 |

Notes: *** $p < 0.01$; parentheses are standard error.

### *5.2. Benchmark Regression via Two-Way Fixed Effect Model*

Table 6 reports the benchmark regression results of the impact of fiscal decentralization on natural poverty at the county level using a two-way fixed effect model. Columns (1)–(3) show the results of the regression with only the core explanatory variables and the response variables, indicating that county fiscal decentralization, whether measured by county fiscal autonomy or county general budget revenue (expenditure) decentralization, has a positive impact on the natural poverty index, with the results being significantly positive at the 1% level. Columns (4)–(6) show the regression results after adding a series of control variables, and results are also significantly positive at the 1% level. In general, the current situation of fiscal decentralization at the county level in China is consistent with the second-generation fiscal decentralization theory, that is, when faced with mismatched fiscal autonomy and local fiscal pressure, fiscal decentralization at the county level will exacerbate regional natural poverty, confirming Hypothesis 1.

As for the control variables, GDP per capita significantly hinders the county natural poverty index, which indicates that an increase in regional economic strength helps to reduce local natural poverty. The number of industrial enterprises significantly enhances the county natural poverty index, implying that natural poverty and industrialization take a similar trend. The proportion of elementary school students in school has a significantly positive effect on the natural poverty index, while the influence of the proportion of secondary school students in school is significantly negative, denoting that the structure of human capital, i.e., the level of technology, is closely related to the degree of natural

poverty. The scarcity of human capital aggravates natural poverty, while the technology effect brought by high levels of human capital can effectively alleviate the natural poverty problem. The coefficient of control variables preliminarily verified the mechanism hypothesis of fiscal decentralization affecting natural poverty mentioned in Section 2.2.

**Table 6.** Impact of fiscal decentralization on the natural poverty index.

| Variables | (1) NPI | (2) NPI | (3) NPI | (4) NPI | (5) NPI | (6) NPI |
|---|---|---|---|---|---|---|
| finance1 | 0.161 *** | | | 0.133 *** | | |
| | (9.07) | | | (7.61) | | |
| finance2 | | 0.067 *** | | | 0.058 *** | |
| | | (3.04) | | | (2.74) | |
| finance3 | | | 0.093 *** | | | 0.085 *** |
| | | | (4.31) | | | (4.01) |
| ln *population* | | | | 0.095 *** | 0.096 *** | 0.097 *** |
| | | | | (3.47) | (2.92) | (2.97) |
| ln *GDP* | | | | −0.730 *** | −0.659 *** | −0.660 *** |
| | | | | (−8.76) | (−6.69) | (−6.74) |
| ln $GDP^2$ | | | | 0.051 *** | 0.052 *** | 0.052 *** |
| | | | | (11.93) | (11.40) | (11.50) |
| industry2 | | | | −0.036 | −0.064 ** | −0.061 ** |
| | | | | (−1.37) | (−2.19) | (−2.07) |
| ln *enterprise* | | | | 0.015 *** | 0.022 *** | 0.022 *** |
| | | | | (3.37) | (4.21) | (4.19) |
| ln *student*1 | | | | 0.065 *** | 0.065 *** | 0.064 *** |
| | | | | (6.33) | (5.64) | (5.64) |
| ln *student*2 | | | | −0.047 *** | −0.046 *** | −0.045 *** |
| | | | | (−6.20) | (−5.30) | (−5.19) |
| ln *hospital* | | | | −0.004 | 0.006 | 0.006 |
| | | | | (−0.58) | (0.73) | (0.71) |
| Company FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 6.466 *** | 6.199 *** | 6.190 *** | 8.364 *** | 7.407 *** | 7.387 *** |
| | (636.51) | (810.98) | (794.34) | (18.50) | (13.69) | (13.71) |
| Observations | 34,833 | 27,784 | 27,779 | 34,833 | 27,784 | 27,779 |
| $R^2$ | 0.282 | 0.264 | 0.264 | 0.317 | 0.302 | 0.302 |

Notes: *** $p < 0.01$, ** $p < 0.05$; parentheses are cluster-robust standard errors at the county level.

### *5.3. Robustness Checks*

#### 5.3.1. Instrumental Variables Estimation

The baseline regression may miss certain factors that affect both fiscal decentralization and regional natural poverty (e.g., resource endowments or locational characteristics that are difficult to measure accurately); therefore, the instrumental variables approach is used to overcome endogeneity. Referring to Zhan Xinyu and Liu Wenbin (2020), for the fiscal decentralization of a county, this paper uses the average of the degree of fiscal decentralization of other county administrative units within the same prefecture-level city as the instrumental variables [47]. Thus, three instrumental variables (iv_finance1, iv_finance2, iv_finance3) corresponding to the fiscal autonomy of the county (finance1) and the decentralization of the general budget revenue (expenditure) of the county (finance2, finance3) are obtained, respectively. The rationale of the appliance of the above instrumental variables is as follows: on one hand, the fiscal decentralization systems among county governments within the same prefecture-level city are similar and hence satisfy the requirement of correlation; moreover, a missing variable at the county level cannot affect the fiscal decentralization system and government revenue and expenditure behavior of other counties, which meets the exogenous requirements. Therefore, the construction of this instrumental variable theoretically meets the conditions required for it to be used as an instrumental variable. Table 7 shows the estimation results of the instrumental variables method. Columns (4)–(6) show the regression results of the first stage, the regression coefficients of the three instrumental variables are significantly positive, and the values of the F-statistics (first-stage F-test) are 1102, 2534 and 6813, all greater than 10, indicating that the instrumental variables pass the

weak instrumental variable test and meet the requirements of exogeneity and the selection of instrumental variables is reasonable. The estimated coefficients of fiscal decentralization remain significantly positive in the second-stage regressions in columns (1)–(3), which are consistent with benchmark regression results, which means after overcoming the endogeneity problem with the instrumental variable method, the regression results are still robust. Due to the large number of control variables in this paper, and the control variables selected in all regressions remain unchanged, the subsequent tables in this paper will not specifically report the correlation coefficient of control variables but only show whether control variables are included in the regression model.

**Table 7.** Robustness checks (instrumental variables estimation).

| Variables | (1) Two NPI | (2) Two NPI | (3) Two NPI | (4) First finance1 | (5) First finance2 | (6) First finance3 |
|---|---|---|---|---|---|---|
| finance1 | 0.328 *** | | | | | |
| | (9.45) | | | | | |
| finance2 | | 0.061 ** | | | | |
| | | (2.36) | | | | |
| finance3 | | | 0.077 *** | | | |
| | | | (3.14) | | | |
| iv_finance1 | | | | 0.553 *** | | |
| | | | | (33.20) | | |
| iv_finance2 | | | | | 0.751 *** | |
| | | | | | (50.33) | |
| iv_finance3 | | | | | | 0.845 *** |
| | | | | | | (82.54) |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| First-stage F-test | | | | 1102 | 2534 | 6813 |
| Observations | 34,701 | 27,695 | 27,689 | 34,701 | 27,695 | 27,689 |
| $R^2$ | 0.308 | 0.302 | 0.302 | | | |

Notes: *** $p < 0.01$, ** $p < 0.05$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

#### 5.3.2. Alternative Response Variables

The existing research on natural poverty is at the initial stage, especially since the selection of a natural poverty evaluation system and index measurement are still incomprehensive. To reflect the differences in the effects produced by various measurement methods in a more general approach, this study uses the entropy weight method to re-estimate the weights of the natural poverty evaluation system to obtain a new county natural poverty index ($NPI_1$) and regression results. Table 8 reports the estimation results after replacing the response variables. Columns (1)–(3) show the results of the two-way fixed model regression with only the core explanatory variables and the response variables calculated by the entropy method, in which fiscal decentralization measured by fiscal autonomy and general budget expenditure decentralization both have significant positive effects on the county natural poverty index and that measured by general budget revenue decentralization is insignificant. Columns (4)–(6) show the regression results after adding a series of control variables. The influence of fiscal decentralization measured by fiscal autonomy and general budget revenue decentralization on NPI is significantly positive at the 5% level, and the influence of fiscal decentralization measured by general budget expenditure decentralization on NPI is significantly positive at the 1% level. The estimation results are consistent with benchmark regression, which is robust.

**Table 8.** Robustness checks (alternative response variables).

| Variables | (1) $NPI_1$ | (2) $NPI_1$ | (3) $NPI_1$ | (4) $NPI_1$ | (5) $NPI_1$ | (6) $NPI_1$ |
|---|---|---|---|---|---|---|
| finance1 | 0.016 *** | | | 0.007 ** | | |
| | (4.38) | | | (2.14) | | |
| finance2 | | 0.003 | | | 0.010 ** | |
| | | (0.76) | | | (2.41) | |
| finance3 | | | 0.017 *** | | | 0.015 *** |
| | | | (3.29) | | | (2.91) |
| Control variables | NO | NO | NO | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 0.514 *** | 0.471 *** | 0.467 *** | 1.181 *** | 1.525 *** | 0.921 *** |
| | (233.35) | (289.93) | (274.33) | (13.64) | (20.85) | (8.83) |
| Observations | 34,833 | 27,784 | 27,779 | 34,833 | 27,784 | 27,779 |
| $R^2$ | 0.246 | 0.254 | 0.255 | 0.299 | 0.324 | 0.305 |

Notes: *** $p < 0.01$, ** $p < 0.05$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

#### 5.3.3. Lag 1 Autocorrelation

The formation of a regional ecological environment is not achieved overnight, and the comprehensive policy represented by fiscal decentralization has a certain time lag in the process of transmitting influence and changing regional ecological pattern. Therefore, this paper selects the fiscal decentralization index with a lag of one stage as the core explanatory variables (L.finance1, L.finance2, L.finance3) for regression. In order to more accurately identify the relationship between fiscal decentralization and county natural poverty index and avoid the possible problem of circular demonstration, the regression test was conducted on the natural poverty index (NPI) calculated by the BP neural network model and the natural poverty index ($NPI_1$) calculated by Section 5.3.2 via the entropy method using fiscal decentralization index with a lag of one stage. All regressions control other variables, and the results are shown in Table 9. Columns (1) to (3) show the regression results of the fiscal decentralization level in one period of lag with the natural poverty index measured by the BP neural network model, and columns (4) to (6) show the regression results of the fiscal decentralization level in one period of lag with the natural poverty index measured by entropy method. It shows that the level of fiscal decentralization in the county with one period of lag has a significant contribution to the natural poverty index under both measurement methods, confirming the robustness of the regression results.

**Table 9.** Robustness checks (lag 1 autocorrelation).

| Variables | (1) NPI | (2) NPI | (3) NPI | (4) $NPI_1$ | (5) $NPI_1$ | (6) $NPI_1$ |
|---|---|---|---|---|---|---|
| L.finance1 | 0.123 *** | | | 0.012 *** | | |
| | (7.07) | | | (3.39) | | |
| L.finance2 | | 0.090 *** | | | 0.011 *** | |
| | | (4.29) | | | (2.62) | |
| L.finance3 | | | 0.120 *** | | | 0.020 *** |
| | | | (6.00) | | | (4.45) |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 8.140 *** | 7.395 *** | 7.374 *** | 1.215 *** | 0.995 *** | 0.989 *** |
| | (17.24) | (13.19) | (13.24) | (13.91) | (9.35) | (9.34) |
| Observations | 32,905 | 26,223 | 26,218 | 32,905 | 26,223 | 26,218 |
| $R^2$ | 0.258 | 0.239 | 0.240 | 0.282 | 0.283 | 0.284 |

Notes: *** $p < 0.01$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

### *5.4. Heterogeneity Investigation*

#### 5.4.1. Heterogeneity of Natural Poverty Formation

Considering the differences in the formation mechanisms of natural poverty patterns among counties which may lead to differences in the influence level of fiscal decentralization on the natural poverty index, this article further classifies counties into three natural poverty formation types of topographic poverty ($NPI_D$), natural resource poverty ($NPI_Z$) and ecological burden poverty ($NPI_S$) according to the proportion of dimensional natural poverty indicator in the summary natural poverty index. The subsample regression tests are conducted afterward to examine the role of fiscal decentralization on natural poverty under the differences of natural poverty formation types, and all regression results have other variables controlled. The estimation results reported in columns (1)–(3) of Table 10 show that the impact of fiscal decentralization on the natural poverty index is insignificant for counties where natural poverty is caused by topography factors, since topography indicators are fixed locational and geographical characteristics of counties that remain unchanged regardless of fiscal policies. Columns (4)–(9) demonstrate the significant positive influence of fiscal decentralization on the response variables in both natural resource and ecological burden poverty, indicating that the county government behaviors directed by fiscal decentralization have an impact on a variety of natural resources and ecological environments such as vegetation, arable lands and pollutant emissions, thus affecting the local natural poverty level.

**Table 10.** Heterogeneity investigation (heterogeneity of natural poverty formation).

| Variables | (1) $NPI_D$ | (2) $NPI_D$ | (3) $NPI_D$ | (4) $NPI_Z$ | (5) $NPI_Z$ | (6) $NPI_Z$ | (7) $NPI_S$ | (8) $NPI_S$ | (9) $NPI_S$ |
|---|---|---|---|---|---|---|---|---|---|
| finance1 | −0.002 | | | 0.220 *** | | | 0.177 *** | | |
| | (−0.04) | | | (5.95) | | | (10.18) | | |
| finance2 | | −0.570 | | | 0.095 ** | | | 0.081 *** | |
| | | (−1.05) | | | (2.29) | | | (3.80) | |
| finance3 | | | 0.282 | | | 0.093 ** | | | 0.042 ** |
| | | | (1.35) | | | (2.45) | | | (2.02) |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 5.122 *** | 7.734 * | 8.398 ** | 6.624 *** | 9.748 *** | 7.005 *** | 10.344 *** | 10.564 *** | 10.532 *** |
| | (4.19) | (1.92) | (2.07) | (11.28) | (11.18) | (15.98) | (37.68) | (30.55) | (30.19) |
| Observations | 1434 | 277 | 277 | 7605 | 5184 | 5256 | 25,797 | 22,325 | 22,326 |
| $R^2$ | 0.571 | 0.652 | 0.652 | 0.324 | 0.385 | 0.393 | 0.300 | 0.270 | 0.269 |

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

#### 5.4.2. Province-Managing-County Reform

China's vertical organizational structure centered on "province-city-county", complemented by the dual incentives of fiscal decentralization and political centralization, has achieved great success. However, its drawbacks have also emerged, as municipal governments have retained and misappropriated financial subsidies given to county governments by the central and provincial governments, resulting in widespread financial difficulties for county governments [48]. Against this backdrop, the province-managing-county reform implementation began in 2004, with the core objectives of the fiscal simplification of the finance structure. As of 2020, the number has reached a total of 1089 counties in 27 provinces in China. The province-managing-county reform involves various aspects of local financial and administrative power, such as the province's separate approval of financial transfers and special subsidies to province-managing counties, which serve as important influential factors of local government behaviors. There may be a potential relationship between the impact of fiscal decentralization on the county natural poverty index and the province-managing-county reform policy.

Since the initial time of policy implementation varies from counties, this study refers to the approach of Chen Sixia and Lu Shengfeng (2014) of setting two dummy variables:

time dummy $TIME_t$, which assigns to 0 before the implementation of the policy in the sample counties and 1 after the implementation; the second is the regional dummy $SZ_c$, which assigns to 1 for counties that have implemented the policy and 0 for counties that have not [45]. Therefore, the coefficient (result of DID estimation) of the interaction of two dummy variables $TIME_t \times SZ_c$, the key explanatory variable, measures whether the change in the natural poverty index of the county with the policy implemented is significant from that of the county without it. The regression result has other variables controlled and is significantly negative at the 1% level (as shown in Table 11), indicating that, contrary to the benchmark regression results, the implementation of the reform policy significantly improves the natural poverty stage at the county level. The reform of the fiscal system, province-managing-county reform, is different from the usual improvement of the level of fiscal decentralization at the county level. The targeted expansion of the financial autonomy of local governments at the county level and the use of expanded financial power to ensure the supply of public goods such as people's livelihood and the environment can be conducive to giving full play to their own stronger information advantages and alleviating the deterioration of the local ecological environment caused by extensive fiscal decentralization. Thus, the pattern of natural poverty in counties is optimized.

**Table 11.** Heterogeneity investigation (province-managing-county reform)).

| **Variables** | **(1)**<br>**NPI** |
|---|---|
| $TIME_t \times SZ_c$ | −0.027 *** |
| | (−4.33) |
| Control variables | Yes |
| Company FE | Yes |
| Year FE | Yes |
| Constant | 9.154 *** |
| | (31.14) |
| Observations | 34,839 |
| Number of id | 1706 |
| $R^2$ | 0.301 |

Notes: *** $p < 0.01$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

### *5.5. Mechanism Analysis*

#### 5.5.1. The Effect of Tax Incentives

According to the mechanism hypothesis analysis of the impact of county fiscal decentralization on natural poverty in Section 2.2.1, the impact of county fiscal decentralization on the local ecological environment is closely related to the race to the bottom of taxation between regions. To test whether the transmission channel of "county fiscal decentralization → tax incentive benefits → increased natural poverty" is valid, the actual county tax burden after per capita standardization (L.lnperTax) is used to describe the actual county tax level, and the relationship between the degree of fiscal decentralization, local tax level and natural poverty index is investigated. To ensure the robustness of the regression results, the explanatory variables in the mechanism test part are all processed with a one-stage lag, and there is no further discussion. All the regression results controlled other variables. Columns (1) to (3) in Table 12 are the baseline regression models of county fiscal decentralization and local tax revenue level. The estimated results show that county fiscal decentralization is significantly positively correlated with local tax revenue level, indicating that the Chinese-style fiscal decentralization system marked by "fiscal decentralization and administrative centralization" does have tax incentives for county governments. The promotion of county financial autonomy strengthens the tax competition mode in the short term. Column (4) of Table 12 is the baseline regression model of local tax level and natural poverty index. The estimated results show that regional tax burden level has a significant

positive impact on natural poverty index and tax competition worsens the level of natural poverty in counties. The above path transmission results confirm Hypothesis 2a, that is, tax incentive effect is an important way for fiscal decentralization to affect natural poverty level in counties.

**Table 12.** Mechanism analysis (the effect of tax incentives).

| **Variables** | **(1)** ln *perTax* | **(2)** ln *perTax* | **(3)** ln *perTax* | **(4)** **NPI** |
|---|---|---|---|---|
| L.finance1 | 0.665 *** | | | |
| | (8.83) | | | |
| L.finance2 | | 0.362 *** | | |
| | | (3.27) | | |
| L.finance3 | | | 0.236 * | |
| | | | (1.93) | |
| L.ln *perTax* | | | | 0.044 *** |
| | | | | (8.97) |
| Control variables | Yes | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Constant | −6.947 *** | −7.372 *** | −7.236 *** | 7.652 *** |
| | (−4.53) | (−4.26) | (−4.15) | (11.80) |
| Observations | 11,201 | 8959 | 8961 | 11,198 |
| $R^2$ | 0.759 | 0.777 | 0.777 | 0.153 |

Notes: *** $p < 0.01$, * $p < 0.1$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

#### 5.5.2. Composition Effect

According to the mechanism hypothesis in Section 2.2.2, increased tax competition will lead to higher production capacity in environmentally outdated industrial sectors, and the neglect of the local government's spending preferences for livelihood-based public goods supplies is also detrimental to the development of a service-dominated tertiary industry. Fiscal decentralization directly influences the regional industrial structure and thus radiates to ecological and environmental resources. In examining whether the transmission channel of "county fiscal decentralization → composition effect → aggravation of natural poverty" is feasible, in this paper, the proportion of the added value of secondary industry and tertiary industry (industry2, industry3) is used to describe the local industrial structure, and the relationship between fiscal decentralization, industrial structure and natural poverty index was investigated, respectively. All regression results controlled for other variables. In Table 13, columns (1) to (3) and (5) to (7) represent the benchmark regression models of fiscal decentralization and the proportions of secondary industry and tertiary industry, respectively. The estimated results show that fiscal decentralization has a significant positive promoting effect on regional industrial development, while significantly hindering the tertiary industry. Columns (4) and (8) in Table 13 show the benchmark regression model of the impact of the proportion of the secondary industry and the proportion of the tertiary industry on the natural poverty index, respectively. The estimated results show that the manufacturing industrialization of industrial structure significantly increases the natural poverty index, while the service-based industrial structure can effectively alleviate natural poverty. The findings above support the previous composition effect argument that fiscal decentralization reinforces the rigidity of the industrial structure dominated by low- and middle-end manufacturing, discourages industrial structure upgrading and thus further worsens county natural poverty, which verifies Hypothesis 2b.

**Table 13.** Mechanism analysis (composition effect).

| Variables | (1) industry2 | (2) industry2 | (3) industry2 | (4) NPI | (5) industry3 | (6) industry3 | (7) industry3 | (8) NPI |
|---|---|---|---|---|---|---|---|---|
| L.finance1 | 0.118 *** | | | | −0.033 *** | | | |
| | (11.64) | | | | (-4.59) | | | |
| L.finance2 | | 0.044 *** | | | | −0.027 *** | | |
| | | (3.63) | | | | (−2.94) | | |
| L.finance3 | | | 0.019 * | | | | −0.019 ** | |
| | | | (1.74) | | | | (−2.08) | |
| L. industry2 | | | | 0.076 ** | | | | |
| | | | | (2.49) | | | | |
| L. industry3 | | | | | | | | −0.059 * |
| | | | | | | | | (−1.72) |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | −0.198 | −0.340 * | −1.299 *** | 6.137 *** | 0.163 | 0.186 | 0.187 | 6.083 *** |
| | (−1.27) | (−1.89) | (−13.28) | (30.23) | (1.38) | (1.53) | (1.53) | (30.14) |
| Observations | 33,286 | 26,549 | 26,549 | 33,024 | 33,285 | 26,549 | 26,549 | 33,023 |
| $R^2$ | 0.366 | 0.384 | 0.543 | 0.235 | 0.468 | 0.492 | 0.491 | 0.234 |

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

#### 5.5.3. Technology Effect

According to the mechanism hypothesis in Section 2.2.2, in addition to discouraging the upgrading of industrial structure, county governments' spending preferences may also suppress technological progress by reducing the intensity of human capital investment, which is ultimately reflected in the ecological status of the region. To examine whether the transmission mechanism of "county fiscal decentralization → technology effect → increased natural poverty" is valid, this paper describes the local human capital structure with the proportion of middle school students (STUDENT), which means that the greater the proportion of people who choose to receive higher education, the greater the intensity of local human capital investment and the stronger the ability of technological progress. Based on this, the relationship between fiscal decentralization, technological progress and natural poverty index was investigated, and all regression results controlled for other variables. Columns (1) to (3) in Table 14 are the baseline regression models of county fiscal decentralization and technological progress. The estimated results show that county fiscal decentralization had a significant negative correlation with the proportion of secondary school students, which means that the local government's fiscal spending demonstrates a lack of investment in the supply of public goods such as human capital, reducing the level of local technological progress. Column (4) of Table 14 is the baseline regression model of technological progress and natural poverty index, and results show that technological advancement represented by the optimization of human capital structure suppresses the natural poverty index. Therefore, it can be concluded that the hindrance of technological progress by the increasing degree of fiscal decentralization at the county level significantly accelerates natural poverty. This proves the technical effect hypothesis of the foregoing conclusion, and Hypothesis 2b holds.

**Table 14.** Mechanism analysis (technology effect).

| Variables | (1) STUDENT | (2) STUDENT | (3) STUDENT | (4) NPI |
|---|---|---|---|---|
| L.finance1 | −0.472 *** | | | |
| | (−6.53) | | | |
| L.finance2 | | −0.362 *** | | |
| | | (−4.51) | | |
| L.finance3 | | | −0.161 ** | |
| | | | (−2.21) | |
| L.STUDENT | | | | −0.014 *** |
| | | | | (−8.61) |
| Control variables | Yes | Yes | Yes | Yes |
| Company FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Constant | −35.661 *** | −37.122 *** | −37.170 *** | 5.782 *** |
| | (−34.41) | (−31.79) | (−31.55) | (32.05) |
| Observations | 32,068 | 25,514 | 25,514 | 32,054 |
| $R^2$ | 0.857 | 0.877 | 0.876 | 0.235 |

Notes: *** $p < 0.01$, ** $p < 0.05$; parentheses are cluster-robust standard errors at the county level. Only estimations of core explanatory variables are shown in the table due to space limitations.

## 6. Conclusions and Policy Recommendations

### *6.1. Research Conclusions*

This article innovatively measures the natural poverty index of 1712 counties and county-level cities in China and related county data based on a BP neural network and empirically tests the impact of county fiscal decentralization on natural poverty and the transmission mechanism during 2000–2020 using a two-way fixed-effects model to provide a new explanation on how fiscal decentralization affects regional natural poverty alleviation and thus green growth and sustainable development. The main findings are as follows:

(1) With the development of the fiscal decentralization system with Chinese characteristics in the five levels of the government management system, the change in local government revenue and expenditure behavior caused by increased county fiscal autonomy significantly aggravates the regional natural poverty, and this finding stands with a series of robustness tests. (2) The heterogeneity analysis shows that the positive effect of county fiscal decentralization on natural poverty index varies in regions with different natural poverty formation mechanisms, and its effect persists for natural resource poverty and ecological burden poverty counties but is insignificant in topographic poverty regions. In addition, province-managing-county reform significantly improves the situation of county natural poverty, suggesting that what aggravates regional natural poverty is the extensive fiscal and taxation system during the initial economic development and that optimized fiscal decentralization facilitates the alleviation of natural poverty. (3) The mechanism analysis found that local revenue impacts and expenditure preferences that accompanied county fiscal decentralization contribute to the deterioration of regional natural poverty by intensifying the race to the bottom of taxation, guiding industrialization and impeding technological advancement.

### *6.2. Policy Recommendations*

Based on the conclusions above, this paper proposes the following policy recommendations.

First, improve the county fiscal decentralization system, enforce the concept of green finance, and emphasize the important role of fiscal revenue and expenditure in improving natural poverty in counties. On the aspect of revenue, the leverage of financial resources should be given full play through tax relief, government subsidies and other preferential policies to guide more social capital to enter the field of ecofriendly industries and promote

the upgrading of social industrial capacity structure. On the expenditure side, the government should optimize the fiscal expenditure structure, give key support to ecological environmental protection and industrial upgrading in terms of funds and policies and at the same time increase expenditure on human capital and other public goods of human livelihood, to promote ecological and economic poverty alleviation in an integrated approach.

Second, improve environmental protection compensation mechanisms and market incentive systems. Increase ecological compensation and utilize the reform of the fiscal and taxation system, such as province-managing-county reform, to increase the scale of ecological transfer payments and strengthen support for high natural poverty regions. Meanwhile, the government should establish a differentiated compensation mechanism, designate a discrepant line according to the regional natural poverty level and increase the financial and administrative allocation attention to areas with a higher percentage of ecological protection line coverage. A robust market incentive system, on the other hand, should require local governments to be able to use market mechanisms to ease the ecological burden on counties, alter traditional high-consumption and high-emission production patterns and promote green growth and a sustainable economy.

Third, governments should formulate customized mitigation programs for different natural poverty areas, and local governments should scientifically optimize the structure of settlements based on altitude, topography and other environmental features and build priority villages and special villages to actively cope with natural poverty. On the foundation of improving the emission market mechanism, it is essential to vigorously broadcast the importance of ecological construction and idea of sustainable development. The government should raise the awareness of the public related to natural poverty alleviation, which is indispensable to economic poverty alleviation, thus stimulating the community's motivation to participate in environmental protection.

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