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The Impact of the South-North Water Transfer Project on Poverty Reduction in the Qinba Mountain Region and Countermeasures-An Empirical Analysis Based on the DID Model

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Abstract:

The South-North Water Diversion project is China's largest water resource control project. The danjiang water source area of the middle route of the project alleviates the water shortage in northern China. However, Danjiang water source area is also the poverty-stricken area of Qinba Mountains in China, so there is a certain contradiction between water source protection and economic development. This paper attempts to study the impact of the South-North water Transfer project on poverty alleviation in Qinba Mountains from an empirical perspective. This paper summarizes the middle route of South-North Water Diversion project and the poverty reduction work in Danjiang water source area by on-site investigation, and points out the significance of the project, the current situation of poverty reduction in Qinba Mountain area, the effect of poverty reduction and the constraints of poverty reduction. Then, using the empirical method, choose the dual difference model, take 2005 as the node, sort out the panel data of seven cities from 2001 to 2013, analyze the panel data as a whole and in sections respectively, and verify the impact of the project on rural economic development. The results show that the middle route of the South-North Water Diversion project has a certain stimulating effect on economic growth and poverty reduction in the Danjiang water source region, but the impact is not significant. In terms of stages, the positive impact of the middle route project on the economic growth of the Danjiang water source area is weakening, and even hindering economic development, which has a negative impact on poverty reduction in the Qinling-Daba mountain area. According to the analysis results and the practical basis of the development of Danjiang water source region, the paper puts forward concrete and feasible suggestions to solve the contradiction between poverty reduction and water source protection in area of Qinba Mountains from the aspects of establishing multi-dimensional linkage development mechanis.

Keywords: *The south-north water transfer project, Poverty reduction, DID Model.*

I. BACKGROUND

Shiyan City in Hubei Province is the location of the Danjiangkou Reservoir, the core water source area

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of the South-to-North Water Diversion Project. It is located in the northwestern part of Hubei Province, with four counties, one city and three districts under its jurisdiction (Yu Xi County, Zhu Xi County, Fang County, Zhushan County, Danjiangkou City, Zhang Wan District, Mao Arrow District and Yu Yang District). The Danjiangkou Reservoir is located at the confluence of the Han River and its tributary, the Dan River, and is the largest artificial freshwater lake in Asia. The water source area mainly includes the Han River and the main stream of the Dan River, of which the Dan River reservoir area covers the entire Shiyan region. In order to protect the ecological environment of the water source and ensure water quality, the South-North Water Diversion Central Project has imposed a high standard of ecological requirements on Shiyan City, which has had a major impact on the local economic development.

At the same time, the four counties, one city and three districts under the jurisdiction of Shiyan City are all national poverty-stricken counties, belonging to the Qinba Mountain concentrated contiguous poverty area of China's three major poverty-stricken areas, which is a key area for poverty reduction in China and an important area for poverty alleviation in Hubei Province. At present, economic development is lagging behind, the industrial base is weak and the task of poverty eradication is arduous, which is the reality of Shiyan City.

In his keynote speech at the 2015 High Level Forum on Poverty Reduction and Development, President Xi Jinping said, "In the next five years, we will lift all 70 million people out of poverty under China's existing standards". He also pointed out that "an important step in China's poverty alleviation efforts is to implement a precise poverty alleviation strategy, find the "root causes of poverty", prescribe the right medicine and target treatment". Shiyan is not only the core water source of the South-North Water Diversion Project, it is also a special hardship area in the Qinba Mountains. In terms of the traditional approach to poverty reduction, there is a certain conflict between the two goals of development and ecological protection in Shiyan, which is one of the "root causes" of poverty in Shiyan. The decision to reduce poverty in Shiyan is therefore no longer a question of which comes first, the environment or the economy, but a harmonious way to balance the protection of water sources and regional development. Therefore, the coordination between water source protection and poverty reduction has become a real issue for the success of Shiyan's development. It is this realistic background that drives the group to explore the relationship between the South-North Water Diversion Project and poverty reduction in Shiyan at a deeper level.

Based on the above understanding, this paper first summarises the situation of the South-North Water Diversion Central Line Project and poverty reduction in Shiyan, and then analyses the impact of the construction of the South-North Water Diversion Central Line Project on economic development and poverty reduction in Shiyan through an empirical approach, using the double-doubled difference model (DID model), in an attempt to determine whether the construction of the South-North Water Diversion Central Line Project has had an impact on the economic development of the core water source area, the positivity and negativity of the impact, and the extent of the impact. The study also proposes corresponding countermeasures in the light of the actual situation of poverty reduction development in Shiyan. On the one hand, this study can enrich the existing research on the South-North Water Transfer

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Central Project and the economic development of core water source areas in terms of theoretical analysis; on the other hand, through empirical analysis, the actual impact of the construction of the South-North Water Transfer Central Project on poverty reduction in Shiyan City, Hubei Province can provide a strong basis for the formulation of decisions related to the development of Shiyan City under the dual objectives of water source protection and poverty reduction, and provide a strong basis for the development of the key areas of poverty alleviation in the province. It will also provide some help to the key areas of poverty alleviation in the province to get out of poverty on time.

II. REVIEW OF THE LITERATURE

Research on the construction of the South-North Water Diversion Project is dominated by domestic scholars. Although the construction of the South-North Water Diversion Project has a relatively prominent role, there are still some adverse effects. The following is a summary of the adverse effects of the construction project: firstly, the price of water transferred from the south to the north is higher than the local price, which is questioned by some water users in the recipient areas, resulting in a lack of enthusiasm for water use in water-scarce cities; secondly, the actual amount of water resources used is much lower than the amount of water transferred from the south to the north, resulting in too much surplus water entering the reservoir and causing "waste"; thirdly, the ecological environment around the reservoir may be threatened. Thirdly, the ecological environment around the reservoir may be threatened. The topography and geomorphology will change greatly, which will bring secondary disasters, such as earthquakes; the upstream water flow is slow, easy to breed mosquitoes, flies and germs; there is a major drought in the south; fourth, the cost of desalination is reduced, and the construction cost of the project may exceed the cost of desalination; fifth, strategic security issues. The safety of the water transmission channel maintains the safety and security of the general public; sixth, the supporting projects cost a lot of money. For example, the South-to-North Water Transfer Project, in order to raise the dam, resulting in about 345,000 immigrants, in order to maintain the "South-to-North Water Transfer" construction project to play its role, to ensure that the appropriate amount of water, in the long run, the need to divert water from the Three Gorges reservoir area, which means that the Three Gorges may need to raise the dam. As a result, the South-North Water Transfer Project, which cost nearly 500 billion yuan and aims to alleviate water shortages in the north, has encountered bottlenecks in the promotion of water in the receiving areas and has faced questions from all sectors of society.

The South-North Water Diversion Project is one of the "South-North Water Diversion" routes, and has the same problems as the overall project, but also faces special problems arising from its construction, namely the impact on the economic development of the core water source area, which has been studied by many scholars.

(1) The impact of the midline project on agricultural development

Xu Jintao, Tao Ran and Xu Zhigang (2004) [1] raised a similar issue in their article "*Returning farmland to forest: cost effectiveness, structural adjustment effect and economic sustainability*": farmers

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may reclaim their land after the subsidy period, and when the government's goal is to maintain the effect of the policy in the long term and ensure that the land is not reclaimed, it should adopt a policy that allows farmers to reclaim their land from the The government's objective is to maintain the policy's effectiveness in the long term and to ensure that the land is not reclaimed, so it should adopt a sequence of operations that allows farmers to switch from plantations, which are not conducive to soil and water conservation, to forestry, animal husbandry and non-agricultural industries, which are "environmentally sustainable", so that farmers can voluntarily return farmland to forests. The same should be done for the ecological construction of the South-North Water Transfer Project. In addition, the development of agriculture in the water source areas is slow, and the small scale and mechanised process industries do not have a strong ability to "feed" agriculture. Feng Guilin (2002) [2] has studied the industrial structure of the Danjiangkou reservoir area, and the results show that in the 1960s and 1970s, the Danjiangkou reservoir area was mainly composed of an agricultural economy based on farming, and its productivity was at a low level. Although the idea of big agriculture was later promoted and developed, the scale of its industries still struggled to expand and they were all labour-intensive. He also points out in his article that the reservoir area is economically backward and although it has developed since the founding of New China, the construction of the Danjiangkou Water Conservancy Hub Project of the South-to-North Water Diversion Central Project could wipe out nearly a decade of construction. Li Ping (2008) [3] has also made the point that the water transfer area is economically backward, with a large gap between upstream and downstream. The counties and cities are all dominated by agricultural production, with low solid yields due to mostly family-based smallholder production; rough farming has led to low quality livestock farming. It can be seen that the construction of the Central Link project and the implementation of various policies to ensure water quality have indeed dealt a blow to agricultural development and farmers in the water source areas.

In addition, some scholars have also studied and analysed the development of agriculture in the water sources of the South-North Water Transfer Project, pointing out that the construction of special agriculture and sustainable agriculture is an important way to solve the problem. However, in the process of implementation, it is faced with various problems such as lack of projects for development, lack of funds for investment and lack of talents for technology, which makes the characteristic industries in mountainous areas fall into a bottleneck.

In 2014, the Provincial Department of Agriculture announced that "the International Fund for Agricultural Development (IFAD) will support the development of the agricultural industry in Shiyan City in the Qinba Mountain Area, and the fund will provide a loan of US$43.8 million to promote the project area to lift farmers out of poverty as soon as possible". In addition, since 2013, the total investment of foreign capital, industrial and commercial capital, and private capital in the development of special agriculture in Shiyan, Hubei reached more than 30 billion, a mountainous agricultural investment fever led by the three major capitals and linked internally and externally has emerged. Nevertheless, the real implementation effect is still to be tested.

During the construction period of the South-North Water Diversion Project, the per capita net income of farmers in Shiyan area has been at a low level even in the ecological and cultural tourism circle of West

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Hubei only. And as mentioned before, we venture to guess that the construction of the South-North Water Diversion Central Line Project has an adverse impact on the agriculture and net per capita income of farmers in Shiyan, the water source area. The issue will be briefly analysed at the end of Chapter 3.

(2) Impact of the Central Line Project on non-agricultural development

On the issue of industrial structure adjustment and future development direction in the water source area of the project, scholars have also conducted studies and put forward their opinions. Deng Shuhong (2014) [4] has taken Shiyan as an example and studied the industrial structure adjustment in the Danjiangkou Reservoir area and upstream areas, pointing out that Shiyan, as the location of the water source of the South-North Water Diversion Central Project, should actively promote the shift of industrial focus, vigorously develop the development of primary and tertiary industries and reduce the over-reliance on industrial industries in order to ensure the ecological safety and stable economic and social development of the water source area. Guo Xinming (2007, 2008) [5] also proposed in his article the idea of establishing a South-North Water Transfer (Central Line) Watershed Economic Zone based on the allocation of water resources across regions and river basins and the co-ordination of localities within the framework of a market economy, using water as a medium and the central cities along the route as axes. It is even clear that the source of the water transfer should have the mission of meeting the water transfer and protecting the water quality of the source in the future. Zhang Jianquan (2005) [6] conducted a study on the impact of the South-North Water Diversion Project on the economic structure of Danjiangkou County, and pointed out that compared to the top 100 counties in China, Danjiangkou City ranked 434th in terms of "comprehensive development index". In their article, Wang Huaxin and Ma Zemin (2014) [7] point out that the core water source area has the typical characteristics of being "old, small, marginal and poor". Shiyan is located in the northwest of Hubei Province, and most of the reservoir area is located in the Qinba Mountainous Region, with an unreasonable industrial structure and slow economic development, and all economic development indicators are far below the national average. For such a relatively backward region, which relies on "double-high" industries to drive its economic development, the measures taken to ensure the construction of the project are a great blow to its economic development. A comprehensive study of the impact of the South-North Water Diversion Project on the economy of the core water source area reveals the following.

Firstly, regional revenues have been reduced. The inevitable direct impact on fiscal revenues due to land inundation and relocation of enterprises.

Secondly, a reduction in per capita resource possession due to the massive inundation of land and facilities in the reservoir area.

Thirdly, the high environmental requirements mean that we can no longer rely excessively on the secondary industry. The secondary industry has always been the pillar of Shiyan's industry, but as its own development relies on "double high", i.e. high energy consumption and high pollution, this has posed a serious threat to the water quality of the reservoir area, solid Shiyan's industrial structure needs to be

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transformed and optimised, and the pillar industry has been hit.

The core water source area, at a time when its own economy is underdeveloped, has responded positively to the country's call to help alleviate the problem of water scarcity in the north and to ensure the smooth implementation of the South-North Water Diversion Central Project at the expense of stable economic development.

A study on poverty reduction in the concentrated contiguous poverty areas in the Qinba Mountain region, the national contiguous special hardship areas were identified mainly from the 14 zones assigned to them in the spirit of the Outline of China's Rural Poverty Alleviation and Development (2011-2020). Shiyan city district and its subordinate Utopia County (Utopia District), Utopia County, Zhushan County, Zhuxi County, Fang County and Danjiangkou City belong to the concentrated contiguous special hardship areas in the Qinba Mountains. In their article, Xi Heng and Zheng Zijian (2000) [8] have summarised that the main types of poverty in the Qinba Mountains are as follows: poverty due to poor natural and ecological conditions that limit economic development; poverty due to backward production methods; and poverty due to poor education levels and population quality. Ma Yanling (2012) [9] has also written an article analysing the main causes of poverty in the Qinba mountainous areas: poor natural conditions, frequent natural disasters such as earthquakes and mudslides, just fragile ecological environment and remote geographical location; slow industrial development and low level of economic development; poor infrastructure, poor education and culture, training, medical and health conditions, etc. Qin Jianxiong, Zhang Pei and Chen Xing (2013) [10] put forward the idea of constructing a development model and guarantee mechanism for poverty reduction in tourism in the Qinba Mountains. The Dazhou Central Sub-Branch of the People's Bank of China has also analysed the research on the topic of "Finance and anti-poverty: financial support for continuous poverty alleviation and development in the Qinba Mountains - taking Dazhou City, Sichuan Province, as an example"[11] to help poor areas get rid of the current situation through financial support and innovation, and the paper points out that in combining poverty alleviation and development projects with innovative financial products and financial poverty reduction models are still dominated by the farming industry.

Ashenfelter and Card (1985) first proposed the double-difference estimation method (Difference-in-Difference (DID)) in their study of income structure. -Differences (DID), and Wooldridge (2007) argued that DID models can better control for systematic differences between control and treatment groups, and thus reflect the "net effect" of changes in exogenous variables. Ye, Fang and Wang, Yan (2013) [12] have studied the current status of DID applications at home and abroad. The article points out that the DID model was first introduced in 1985 by Ashenfelter and Card of Princeton University, and the method has been gradually accepted for more than a decade since then. The first use of DID in China was by scholars Zhou Li'an and Chen Ye (2005) [13], in their article "Policy effects of rural tax reform in China: estimation based on a double difference model". The use of double difference models is not yet common in China, and their application to the study of the construction effects of the South-North Water Diversion Project is even less common.

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The literature on the economic development of the South-North Water Diversion Project and the core water source areas at this stage all give a fair assessment of the project in terms of both its positive and negative impacts. In addition, there is little published literature on the impact of the South-North Water Diversion Project on poverty reduction in the Qinba Mountains, and no one has introduced the double difference model into this area to conduct empirical research.

III. MODELS AND METHODS

3.1 Analysis Methods and Model Setting

3.1.1 Analysis methods

There are two common comparative methods for examining the impact of the South-North Water Transfer Central Project on poverty reduction in core water source areas.

One is a longitudinal comparison, i.e. comparing the change in GDP in the Shiyan area before and after the construction of the South-North Water Transfer Central Project. However, this method only starts from a single individual and cannot determine whether there is a causal relationship between the resulting impacts and the project. This is because in the process of social development, there is often a synergy of several measures and policies, and due to the influence of many factors, the effect may not be the result of the implementation of the policy or not only the result of the policy, but the synergy of the effect of the implementation of other policies, which may produce a "pseudo-relation" related to the policy.

Another approach is to make a horizontal comparison of the difference in GDP between Shiyan and other counties and cities not affected by the CWB project after the construction of the CWB project. However, the disadvantage of this method is that there are ex ante differences between counties and cities, which may lead to biased comparison results, and this method only examines differences at a certain point in time, whereas construction is often a time period, so this method does not reflect time differences well.

In order to avoid the above problems, this paper will draw on the "Naturaltrial" and "double difference model" in econometrics, also known as the "difference-in-difference method "(DID), to analyse the impact of the South-North Water Transfer Project on the economy of water sources.

(1) Natural experiment

The double difference model is an effective method mostly used in recent years to study the effects of public policy or project implementation. In applying the double difference model, we consider the implementation of the policy as a "natural experiment", which in this paper refers to the South-North Water Transfer Project. Before conducting the analysis, we divided the data into four groups: a pre-implementation effect group, a post-implementation effect group, a pre-implementation experimental group, and a post-implementation experimental group. This natural experiment differs from the usual

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scientific research in that two points need to be noted.

First, the change in public policy must be exogenous. Usually the implementation of a policy or project starts with a pilot and is then generalised, and the path of the pilot is often chosen to suit the actual situation, and it is due to certain 'factors' that the change is chosen to be implemented in a particular location. These locations are not necessarily chosen at random, so the selection of control and effect groups is not usually random, they are derived from a specific policy change and need. The control group is not valid if these 'factors', together with other control variables, influence the implementation of the policy but are not observed. For example, if economic development in Area A relies on agriculture, industry and tourism, and Area B relies only on agriculture and tourism, we observe and select agriculture and tourism as control variables, but there are differences in the way the two economies grow, and the 'industry' factor is bound to affect the error term in the regression, so Area B does not have the validity of the control group.

Secondly, the 'experiment' itself cannot generate endogenous responses, otherwise the estimates of the effects of the project or policy implementation would be endogenously biased. For example, if a poverty reduction policy has an impact on regional economic development, and the area where the policy is implemented is itself a poorly developed area, this could lead to reverse causality and endogeneity errors.

(2) Double difference models

In order to avoid the problems associated with the use of cross-sectional or longitudinal comparison methods, this paper chooses to use the double difference method. The double difference method is used to evaluate the effectiveness of public policies and projects, and can effectively reduce the bias that occurs in natural experiments. By building a model and dividing the data into four groups and double-differencing them to compare the net change in an indicator (the explanatory variable) before and after policy implementation between the effect group and the control group, it is possible to minimise the impact of ex ante differences on the results of the study. The same method can also be used to compare differences over time. Two approaches can be taken when performing double-differencing.

One is to compare the net change in the indicator before and after policy implementation between the effect group and the control group by controlling for the dummy variable of policy implementation or not, for a given indicator, i.e. a longitudinal comparison followed by a cross-sectional comparison.

The other is to compare the difference between the action and control groups before policy implementation, then compare the difference between the two groups after policy implementation, and finally compare the previously obtained differences between the two groups and test for significance by controlling for a dummy variable for time (before and after policy implementation), i.e. a cross-sectional comparison before a longitudinal comparison.

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TABLE I. Diagram of the theoretical structure of the double difference model

	Role Group	Control group	Difference (cross-sectional comparison)
After implementation	A	B	A-B
Pre-implementation	C	D	C-D
Difference(longitudinal comparison)	A-C	B-D	A-B-C-D (times the value of the difference)

By changing the order of the horizontal and vertical comparisons, two methods of comparison can be obtained. The results of these two comparison methods should theoretically be the same, as shown in TABLE I. However, in the actual assessment of policy effects, a longitudinal comparison is usually carried out first, i.e. the net change in each group before and after the implementation of the policy is derived separately, and then the difference between the net change in the two groups is compared.

3.1.2 Model setting

Based on the brief description of the theory of application of the double difference model in the previous section, this section will expand on it with a specific model.

$$y = \beta_0 + \delta_0 d2 + \beta_1 dB + \delta_1 d2 \cdot dB + \mu \tag{3.1}$$

Eq. (3.1) is the basic form of the double difference model, where $d2$ is the time dummy variable (before and after policy implementation), which takes a value of 0 to indicate that the policy is implemented and 1 to indicate that the policy is implemented; dB is the dummy variable for whether an individual implements the policy or not, which takes a value of 0 to indicate that the individual does not implement the policy, i.e. the control group, and 1 to indicate that the individual is affected by the policy, i.e. the effect group; and μ is the error term.

Based on the above model and theoretical structure, we can derive the following derivation.

When $dB = 0$, i.e. in the control group, before and after policy implementation.

$y_1 = \beta_0 \quad d\ 2 = 0$, Before the policy was implemented

$y_2 = \beta_0 + \delta_0 \quad d\ 2 = 1$, After the implementation of the policy

Therefore, the changes in the control group before and after the implementation of the policy were:

Forest Chemicals Review
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$$difl_1 = y_2 - y_1 = (\beta_0 + \delta_0) - \beta_0 = \delta_0 \qquad (3.2)$$

When $dB = 1$, i.e. in the role group, the policy is implemented before and after

$y_1 = \beta_0 \quad d2 = 0$, Before the policy was implemented

$y_2 = \beta_0 + \delta_0 \quad d2 = 1$, After the implementation of the policy

Therefore, the changes in the role groups before and after the implementation of the policy are:

$$difl_2 = y_4 - y_3 = (\beta_0 + \delta_0 + \beta_1 + \delta_1) - (\beta_0 + \beta_1) = \delta_0 + \delta_1 \qquad (3.3)$$

In summary, the changes between the role and control groups before and after the implementation of the policy, i.e.:

$$difl = difl_2 - difl_1 = (\delta_0 + \delta_1) - \delta_0 = \delta_1 \qquad (3.4)$$

The coefficient of the above equation $d2 \cdot dB$ represents the impact of the implementation of a policy on an indicator in the place where the policy is implemented.

In practice, model settings can be divided into: fixed effects models and random effects models. The main difference between the two is that the underlying assumptions are different:

The original purpose of setting up a fixed effects model is to test the effect of each control variable that varies over time on the dependent variable. At this point the error term indicating the time-varying factor is estimated, typically using least squares (OLS).

The significance of setting up a random effects model is to examine those factors that do not vary over time. It introduces into the model such variables that do not vary over time for individuals but affect the dependent variable, at which point μ can then be viewed as consisting of a characteristic α representing individual non-variation over time and a residual ε. Regressions are generally carried out using generalised least squares (GLS), as shown in the model.

$$y = \beta_0 + \delta_0 d2 + \beta_1 dB + \delta_1 d2 \cdot dB + \alpha + \varepsilon \qquad (3.5)$$

In estimating the validity of the two models, the Hausman test is generally used. This means setting the original hypothesis that the random effects model is valid, checking the significance of the p-value results (generally 0.05 is required for empirical studies) and accepting the original hypothesis if the results are not

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significant, or using a fixed effects model if significant.

3.2 Data Sources, Final Model and Variable Selection

3.2.1 Data sources

The data sources used in this paper are mainly the website of the Hubei Provincial Bureau of Statistics, statistical bulletins, annual statistical bulletins, statistical bulletins on national economy and development of each city and state, and the statistical yearbooks of Hubei Province for each year from 2002 to 2014. Shiyan City was selected as the role group, and Yichang, Xiangyang, Jingmen, Jingzhou, Suizhou and Enshi as the control group.

In selecting the control group, it was firstly necessary to ensure the relevance of the study and to minimise inter-regional differences, so other counties and cities covered by the West Hubei Ecological and Cultural Tourism Circle other than Shiyan City were selected as the control group, including: Yichang, Xiangfan, Jingmen, Jingzhou, Suizhou, Enshi, and Shennongjia. The Shennongjia Nature Reserve was solidly removed to avoid the special situation of the directly managed area in terms of economic development.

Although the South-to-North Water Transfer Central Line Project was officially launched in 2003, in the case of Shiyan city, the iconic Central Line water source, the Danjiangkou Reservoir Dam Raising Project, only officially started in September 2005. Therefore, the data used in the empirical analysis in this paper are panel data from the above seven counties and cities from 2001 to 2013, with 2005 as the node.

3.2.2 Variable selection, final model and descriptive statistics of variables

(1) Selection of variables

There are the aforementioned time dummy variables and the dummy variables for policy implementation or not, in addition to other factors that affect GDP as control variables. According to macroeconomic theory, the three driving forces of GDP are "investment", "consumption" and "exports". From the perspective of the expenditure approach to GDP, the main factors affecting GDP are: consumer spending (personal consumption), investment (including housing, plant, equipment and machinery, and inventories), government purchases, and net exports. In contrast, from the perspective of the income approach to accounting, the main factors affecting GDP are: wages, interest, profits, rents, indirect taxes and corporate transfers, depreciation and statistical errors. There is also the production method, which uses the output of each sector to account for GDP. In this paper, the control variables (explanatory variables) to be put into the final model will be selected based on each of the above influencing factors.

1) Value added of the three major industries. The primary sector value added (primary), the secondary sector value added (secondary) and the tertiary sector value added (tertiary) are selected as control

Forest Chemicals Review
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Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

variables. This is because the impact of the three major industries on GDP is prominent when the GDP is accounted for by the production method. And the reason why this paper chooses to use the value added of each industry instead of GDP as the control variable is that there are characteristics such as growth trends and basically similar stage characteristics of growth between GDP and value added of industries, which is confirmed in the article of Liu Heping (2014) [14], "The strategy of strong industrial province is the necessary way to achieve a strong economic province". In addition, in the article "Talking about the relationship between GDP and the added value of various industries"[15], the author also points out that the added value of primary, secondary and tertiary industries constitutes the majority of GDP. Therefore the value added of the three major industries and their growth rates are extracted in the Development Statistics Bulletin of the Hubei Provincial Bureau of Statistics.

2) Total imports and exports (TRADE). Under the expenditure method of accounting, net exports are the main part of the accounting of GDP, while the import amount part does not enter into the accounting. While Zhang Shiqing and Chen Wenzheng (2009) [16] had analyzed the pulling effect of total imports and exports on GDP growth in the article "The Linkage between Total Imports and Exports and GDP Growth", the analysis pointed out that there are many high-tech products and advanced production factors among China's imports, and they all contribute to GDP growth. The raw data are in US$ million, looking up the exchange rates for each year for processing, and are unified with the previous items in billions of dollars. Although it is not necessary to unify the units in the regression analysis, it is important to note the economic implications when interpreting them.

3) General fiscal budget expenditure (fiscal). The relationship between fiscal expenditure and GDP has been of great interest. "Wagner's Law suggests that the fiscal expenditure ratio (the ratio of fiscal expenditure to GNP or GDP) increases with time, the economy and per capita income. Keynes' theory of government spending multipliers also demonstrates the interaction between fiscal spending and GDP. In the paper "Co-integration Analysis and Error Correction Model of the Relationship between Fiscal Expenditure and GDP in China", Wei Bangrong and Yang Yusheng (2006) suggest that the relationship between fiscal expenditure and GDP in China is non-stationary, but in the long run it is co-integrated, highly correlated and has a two-way causal relationship.

4) Savings of urban and rural residents.) From the primary distribution alone, saving is in contrast to consumption and investment, and the savings balance can reflect consumption and investment, both of which are important factors affecting GDP. Therefore, although no specific theoretical basis was found, it was included as a control variable in the final model.

In this paper, gross domestic product (GDP) is selected as the dependent variable; six factors are selected as control variables: primary sector value added (PRIMARY), secondary sector value added (SECOND), tertiary sector value added (THIRD), total imports and exports (TRADE), general budget expenditure (FISCAL), and savings balance of urban and rural residents (SAVINGS).

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

(2) Final model

Based on the above variable treatment, the final model for this paper to study the impact of the South-North Water Transfer Central Project on regional economic development and poverty reduction in water source areas is shown in (3.6):

$$\begin{aligned} \ln gdp &= \beta_0 + \delta_0 d2 + \beta_1 dB + \delta_1 d2 \cdot dB + \beta_2 \ln primary + \delta_2 \ln second \\ &+ \beta_3 \ln third + \delta_3 \ln trade + \beta_4 \ln fiscal + \delta_4 \ln saving + \mu \end{aligned} \quad (3.6)$$

In the above equation, $\ln primary$, $\ln second$, $\ln third$, $\ln trade$, $\ln fiscal$ and $\ln saving$ are: value added of primary industry, value added of secondary industry, value added of tertiary industry, total import and export, general fiscal budget expenditure and savings balance of urban and rural residents, respectively, taken as logarithms.

Generally speaking, taking the logarithm of the data does not change the nature of the data and its relative relationships, while at the same time it reduces the scale of the variables and also makes the data appear smoother, effectively reducing problems such as covariance and heteroskedasticity. In addition, the conclusions obtained from logit regression have elasticity implications and are more economically meaningful.

(3) Descriptive statistics of variables

The data used for the analysis were panel data established for a total of seven counties and cities, namely Shiyan, Yichang, Xiangfan, Jingmen, Jingzhou, Suizhou and Enshi, from 2001 to 2013. TABLE II shows the descriptive statistics of the data values and TABLE III shows the descriptive statistics of the variables obtained after taking the logarithm of the data.

TABLE II. Descriptive statistics of variables

	Not grouped			Role Group			Control group		
Variables (in billion)	Average value	Standard deviation	Number of observations	Average value	Standard deviation	Number of observations	Average value	Standard deviation	Number of observations
gdp	669.19	590.94	91	515.33	297.46	13	694.84	624.27	78
primary	6	5	90	2	2	13	129.52	7	77
second	119.79	79.505	90	62.181	37.548	13	7	80.721	77
third	9	354.19	90	5	5	13	336.23	8	77
trade	325.44	4	89	261.56	155.06	12	4	377.22	77
fiscal	8	171.49	83	4	4	13	221.18	6	70

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

saving	216.94	3	75	191.80	106.91	13	5	180.30	62
	1	33.197		2	2		34.270	3	
	31.427	4		13.186	8.9964		4	34.693	
	6	78.58		7	3		78.317	5	
	80.060	247.2		89.447	76.537		1	79.370	
	5			7	5		359.24	8	
	360.20			364.78	213.47		6	255.26	
	6			3	8			5	

TABLE III. Descriptive statistics of variables

	Not grouped			Role Group			Control group		
Variables	Average value	Standard deviation	Number of observations	Average value	Standard deviation	Number of observations	Average value	Standard deviation	Number of observations
lngdp	6.214	0.748	91	6.094	0.569	13	6.234	0.775	78
lnprimary	4.596	0.616	90	3.397	0.557	13	4.700	0.565	77
lnsecond	5.369	0.897	90	5.413	0.568	13	5.361	0.943	77
lnthird	5.107	0.750	90	5.102	0.591	13	5.108	0.777	77
lntrade	2.873	1.186	89	2.358	0.712	12	2.954	1.228	77
lnfiscal	3.959	0.932	83	4.108	0.946	13	3.9324	0.934	70
lnsaving	5.652	0.720	75	5.744	0.580	13	5.633	0.749	62

4. Empirical Results and Analysis

This paper uses Stata to conduct a DID model analysis of the panel data. The fixed and random effects models were analysed using the least squares (OLS) and generalised least squares (GLS) methods respectively, followed by the Hausman test, which verifies the validity of the fixed and random utility models by testing for contemporaneous correlation between the control variables and the random disturbance terms. It is important to note that the fixed effects model is actually estimated by including all individual dummy variables in the OLS regression, and that the set of all individual dummy variables is perfectly covariant with, i.e. all individual dummy variables can be combined to become, so when using the fixed effects model for the DID regression, the coefficient term is shown as omitted in the regression results.

TABLE IV. Regression results

Before the time period After the	2001~2004 2005~2013 (1)	2001~2005 2006~2013 (2)		2001~2004 2005~2013 (3)	2001~2005 2006~2013 (4)

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

time period					
dudt	13.29** (0.029)	14.78** (0.022)	dudt	0.0354* (0.061)	0.0331* (0.095)
dt	9.679** (0.012)	6.136 (0.112)	dt	0.0243 (0.120)	0.00591 (0.659)
primary	1.028*** (0.000)	1.029*** (0.000)	lnprimary	0.306*** (0.000)	0.306*** (0.000)
second	1.111*** (0.000)	1.095*** (0.000)	lnsecond	0.476*** (0.000)	0.448*** (0.000)
third	0.471*** (0.000)	0.516*** (0.000)	lnthird	0.0606*** (0.002)	0.0722*** (0.000)
trade	0.193* (0.096)	0.203 (0.107)	lntrade	0.00840 (0.525)	0.00725 (0.605)
fiscal	0.212*** (0.001)	0.178** (0.010)	lnfiscal	0.0541** (0.040)	0.0650** (0.025)
saving	0.0560** (0.027)	0.0587** (0.026)	lnsaving	0.0411 (0.129)	0.0521* (0.054)
_cons.	20.53*** (0.000)	20.11*** (0.000)	_cons.	1.432*** (0.000)	1.437*** (0.000)
Hausman test	29.27	27.28	Hausman test	38.66	37.18
R-squared	0.9994	0.9994	R-squared	0.9944	0.9933
Number of samples	69	69	Number of samples	69	69

Note: P-values of regression coefficients in brackets are indicated by *, ** , *** at the 10%, 5% and 1% significance levels respectively (same table below, not separately indicated).

The specific regression results are summarised below:

The year 2005 is in an ambiguous position as the construction of the South-North Water Transfer Central Line Project officially started in September 2005. The data values are first regressed in columns (1) and (2) of TABLE IV, while 2005 is categorised as post-policy implementation in (1) and pre-policy implementation in (2). The Hausman test shows that the fixed effects model results are valid. The regression results show that the South-North Water Diversion Project contributed RMB 1.329 billion and RMB 1.478 billion to the growth of Shiyan's GDP respectively, and passed the test of significance at 5%.

And in columns (3) and (4), the year 2005 is placed after and before the construction of the project respectively, and the logarithm of the data is taken for regression, and the Hausman test shows that the fixed effect model is valid. From the table, it can be seen that the midline project has an impact of 0.0354 and 0.0331 percentage points on Shiyan's GDP growth, and it passed the test with a significance level of 10%.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

4.2 Reasonable Discussion

To further validate the results, segmentation tests were carried out based on the above analysis. The segmentation test provides a clearer picture of the economic impact on the water source area as the project progresses to different time periods.

As can be seen from the second part of the project overview, the reservoir area underwent a large scale migration relocation during the three years from 2009 to 2011, therefore, as shown in TABLE V the data from 2001 to 2004 were regressed against the three time periods 2005 to 2008, 2009 to 2011 and 2012 to 2013 respectively, and the Hausman test showed that the fixed effects model results are valid.

As shown in TABLE V, the analysis results for the two time periods in columns (1) and (2) are positive at 0.0431 and 0.0566, passing the significance tests at 5% and 10% significance levels respectively, indicating that the South-North Water Transfer Central Project has contributed to the development of the economy and poverty reduction in the Shiyan area. And in (3), the coefficient is negative and passes the test of significance level of 1%.

In addition to the above segmentation verification, another segmentation comparison was made as follows. Firstly, 2005 was categorised as before the commencement of the project, and then, in order to maintain consistency in the length of time periods for comparison as far as possible to minimise the impact due to different lengths of time periods, 2003 to 2005 was compared with 2006 to 2008, 2009 to 2011 and 2012 to 2013 respectively.

TABLE V. Segmented regression results (2004)

Before the time period After the time period	2001~2004 2005~2008 (1)	2001~2004 2009~2011 (2)	2001~2004 2012~2013 (3)
dudt	0.0431** (0.041)	0.0566* (0.074)	-0.0945*** (0.004)
dt	0.0113 (0.548)	0.0373 (0.450)	-0.154** (0.023)
lnprimary	0.332*** (0.000)	0.355*** (0.000)	0.312*** (0.000)
lnsecond	0.476*** (0.000)	0.482*** (0.000)	0.367*** (0.000)
lnthird	0.0172 (0.371)	0.0506** (0.023)	0.000782 (0.955)
lntrade	-0.0352 (0.103)	0.0336 (0.151)	-0.0415 (0.131)

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

lnfiscal	0.0486	0.0165	0.299***
	(0.257)	(0.753)	(0.001)
lnsaving	0.150***	0.0176	0.0584
	(0.002)	(0.603)	(0.224)
_cons.	1.085***	1.424***	1.458***
	(0.000)	(0.000)	(0.000)
Huasman test	24.44	19.99	19.38
R-squared	0.9912	0.9907	0.9718
Number of samples	46	43	32

The results in (1) and (2) in TABLE VI are for the fixed effects models that pass the Hausman test, and (3F) and (4R) both indicate the results of the regressions comparing the two time periods 2003 to 2005 and 2012 to 2013. (3F) is the regression result for the fixed utility model that does not pass the Hausman test and is statistically invalid, while in column (4R) the regression result for the random utility model that passes the Hausman test is shown.

Similar to TABLE V, the regression results for the first two time periods are positive, but only in (1) do the regression results pass the test at the 10% level of significance, while in (2) the results are not significant. The regression results are negative in both (3F) and (4R) and pass the significance level of 5% and 10% respectively.

We can see that the regression results for the period 2012 to 2013 are always negative in both categories of segmented comparisons. It is therefore necessary to continue the examination of the 2012 to 2013 segment.

TABLE VI. Segmented regression results (2005)

Before the time period **After the time period**	2003~2005 2006~2008 (1)	2003~2005 2009~2011 (2)	2003~2005 2012~2013 (3F)	2003~2005 2012~2013 (4R)
dudt	0.0187*	0.00458	-0.0414**	-0.0368*
	(0.075)	(0.722)	(0.032)	(0.072)
dt	0.00402	-0.00761	0.00317	-0.0415
	(0.432)	(0.601)	(0.938)	(0.146)
lnprimary	0.241***	0.310***	0.358***	0.279***
	(0.000)	(0.000)	(0.000)	(0.000)
lnsecond	0.413***	0.418***	0.394***	0.444***
	(0.000)	(0.000)	(0.000)	(0.000)
lnthird	0.327***	0.336***	0.324***	0.335***
	(0.000)	(0.000)	(0.000)	(0.000)

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

lntrade	0.00738	0.0109	0.0160	0.0281
	(0.431)	(0.370)	(0.482)	(0.175)
lnfiscal	-0.0223	-0.00558	-0.00873	0.0568***
	(0.238)	(0.783)	(0.834)	(0.002)
lnsaving	0.0296	-0.0412**	-0.0595	-0.127**
	(0.201)	(0.011)	(0.208)	(0.023)
_cons.	1.083***	1.044***	1.118***	1.239***
	(0.000)	(0.000)	(0.000)	(0.000)
Huasman test	17.62	16.80	10.84	10.84
R-squared	0.9964	0.9949	0.9934	0.9997
Number of samples	33	36	25	25

The period 2012 to 2013 has been separated out to eliminate possible errors caused by inconsistencies in the length of the period, as the period only covers two years, so the results of the regressions for the period 2012 to 2013 are presented separately in TABLE VII. Due to the small amount of data and other factors, the regression results below are for a random effects model with a Hausman test.

The results of the logit regressions in columns (2) and (4) in TABLE VII show that when comparing the base periods of 2003 to 2004 and 2004 to 2005 with the 2012 and 2013 periods respectively, the segmental regressions all show negative values. This indicates that the South-North Water Transfer Project had a negative impact on Shiyan's GDP growth and reached -0.0307 percentage points and -0.0414 percentage points respectively, which is consistent with the results of the two types of segmented regressions previously conducted.

TABLE VII. Collapsed regression results

R	Data regression	Logistic regression
2004 as a node	2003~2004	2003~2004
	2012~2013	2012~2013
	(1)	(2)
dudt	0.393	-0.0307*
	(0.317)	(0.066)
2005 as a node	2004~2005	2004~2005
	2012~2013	2012~2013
	(3)	(4)
dudt	1.209	-0.0414**
	(0.420)	(0.033)

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

4.3 Summary Analysis

As can be seen from the derivation of the previous double difference model, the double difference model is obtained by eliminating differences before and after the implementation of the policy and between groups and comparing between groups in terms of the difference in the change in an indicator before and after the implementation of the policy, i.e. the 'difference of differences' (TABLE VIII). Of interest here is the coefficient on the interaction term of the dummy variable, which indicates the impact of the policy on the effect group. This coefficient is used in the text to represent the impact of the South-North Water Transfer Project on the change in GDP in Shiyan, and because the regression is logarithmic, the regression results have an elasticity implication, i.e. the South-North Water Transfer Project has an effect on GDP growth in Shiyan of one percentage point.

TABLE VIII. Double difference model

	Role Group	Control group	Differential
After implementation	$\beta_0+\delta_0+\beta_1+\delta_1$	$\beta_0+\delta_0$	
Pre-implementation	$\beta_0+\beta_1$	β_0	
Differential	$\delta_0+\delta_1$	δ_0	δ_1

(1) Analysis of overall test results

TABLE IX collates the different regression values of *dudt* coefficients in TABLE IV; TABLE V; TABLE VI, where the results in columns (2) and (7) show that the South-North Water Transfer Central Project has a facilitating effect on Shiyan's GDP growth; whereas the *dudt* coefficients in the two types of segmental test results, i.e. columns (5) and (R) in TABLE IX, show negative values, indicating that during the period from 2012 to 2013, the South-North Water Transfer Central Project had a hindering effect on Shiyan's economic development. However, there is no conflict between the two, as the regression results in TABLE IX are the result of conducting a full period analysis, where the effect of the South-North Water Transfer Central Project on the economic impact of the water source Shiyan is offset over a longer period of time. As a result, the final results in TABLE IX show a positive result, whereas in the segmented regressions there may be a negative situation, as shown in (5) and (R) in TABLE IX.

Although the construction of the Central Link Project has had a stimulating effect on the growth of GDP in Shiyan, the core water source area, over the entire longer time period, this does not mean that the South-North Water Transfer Central Link Project has contributed well to the development of Shiyan's economy. As can be seen from columns (1) and (6) in TABLE IX, the effect of the project on the economy is to boost GDP growth by RMB1.329 and RMB1.478 billion, but for a mean value of RMB66.919.6 billion GDP, the contribution values are only 1.986% and 2.2086% respectively, which are not significant. In columns (2) and (7) of TABLE IX, the regression results are significant, but both are only around 0.034

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

percentage points, indicating that the contribution of the Central Link Project to Shiyan's GDP growth is only 0.034 percentage points, which also verifies the above view that the contribution value is not high.

In summary, from the analysis of the whole section, the construction of the South-North Water Transfer Central Project has contributed to economic growth and poverty reduction in Shiyan, but the degree of impact is not significant.

(2) Analysis of segmental test results

As observed in TABLE IX, the results obtained from the segmented regressions with 2004 and 2005 as the time points show similar characteristics in terms of trends: the first two segments have positive regression results, while the third segment, i.e. (5) and (R), has negative regression results. In terms of the specific regression values, the degree of impact is slightly different: the absolute value of the estimates at the 2004 node is significantly larger than the absolute value of the estimates at the 2005 node. The analysis suggests that the main reason for such a difference lies in the different time periods that served as the basis for the implementation of the policy. Since 2001, Shiyan has been experiencing droughts and floods throughout the region, and in 2003, tourism was hit by the SARS epidemic. In addition, the policy of returning farmland to forest and grass to protect water quality also began before the construction of the Central Line Project, dating back as far as 2000. As a result, the longer we go back in time, the greater the gap between this period and the 2009-2011 period, making the gap larger and more significant as GDP itself is in a slump due to natural and non-natural disasters. In addition, 2005 is another low point in the GDP growth rate of Shiyan since 2003, and the average growth rate drops when added to the 2005 period. Therefore, the absolute value of the results of the regression using 2003 to 2005 as the base period is smaller than the absolute value of the results of the regression using 2001 to 2004 as the base period.

The segmental regression results of Group A with 2004 as the time point show an "inverted U", indicating that the project's contribution to Shiyan's economic development peaked between 2009 and 2011, while Group B with 2005 as the time point shows an "inverted U". The segmental regression results of group B with 2005 as the time node show a straight line downward trend, indicating that the impact of the project on economic development of Shiyan has weakened year by year, and even appeared to hinder the economic development. The analysis concluded that the trend of the segmented regression results of Group A was closer to reality. The reasons for this are as follows.

The years 2009 to 2011 were years when large-scale migration relocation was concentrated. To ensure the smooth implementation of the migration project, the government issued special funds and subsidies to resettle migrants, accounting for the release of payments for submerged land and housing. The large amount of government transfer payments resulted in a peak in the impact of the project on Shiyan's GDP growth during this time period. As the peak that occurred in the 2009 to 2011 period was caused by government transfer payments, the adverse impact effect was immediately apparent after the relocation and resettlement of migrants. (5) in TABLE IX shows that the South-North Water Transfer Central Project has caused a hindrance to the growth of Shiyan's GDP.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

TABLE IX: Collapsed regression results

	Data regression	**Logistic regression**			
	Whole section returns		Segmented returns		
2004 as a node (A)	2001~2004 2005~2013 (1)	2001~2004 2005~2013 (2)	2001~2004 2005~2008 (3)	2001~2004 2009~2011 (4)	2001~2004 2012~2013 (5)
dudt	13.29** (0.029)	0.0354* (0.061)	0.0431** (0.041)	0.0566* (0.074)	-0.0945*** (0.004)
2005 as a node (B)	2001~2005 2006~2013 (6)	2001~2005 2006~2013 (7)	2003~2005 2006~2008 (8)	2003~2005 2009~2011 (9)	2003~2005 2012~2013 (R)
dudt	14.78** (0.022)	0.0331* (0.095)	0.0187* (0.075)	0.00458 (0.722)	-0.0368* (0.072)

4.4 Verification of Conjectures

At the end of Chapter 1, "Impact on Agricultural Development", we made a conjecture that the construction of the South-North Water Diversion Project would have an adverse impact on agriculture and net per capita income of farmers in Shiyan, the water source area. In the following, we present a brief analysis of this conjecture, still using the double difference model for the panel data of the seven counties and cities.

In this section, we continue with the previous selection of the effect and control groups, and apply the double difference model to the panel data of the seven counties and cities, and subject them to the Hausman test.

The net rural income per capita (ruralincome) was chosen as the dependent variable and the control variables were selected as follows:

1) Value added in the primary sector (primary). Agriculture is an important component of the primary sector and both have similar growth trends.

2) Value added of the secondary sector (second) and value added of the tertiary sector (third). These two items were chosen as control variables because, in general, the development of the secondary and tertiary sectors "feeds" into the primary sector.

3) General budget expenditure (fiscal). Government subsidies and transfer payments to farmers are also items that constitute farmers' income, so they are replaced by general budget expenditure.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
Article History: Received: 30 March 2022, Revised: 8 April 2022, Accepted: 15 April 2022, Publication: 30 April 2022

4) Total population (population). An increase in total population will lead to an increase in total demand, however, due to the development of transportation and food preservation technology nowadays, people are no longer limited to their location to buy food, so the choice of total population is not theoretical and not very reasonable.

5) Food crop sown area (angriarea). Although mechanical equipment and knowledge of agricultural technology can increase acreage without increasing the area sown for food and subsequently affecting farmers' income, the overall mechanisation level is not high in terms of the actual situation in Shiyan. Therefore, although the data do not conform to the assumption of normal distribution even after taking logarithms, they are still selected as control variables.

The six factors mentioned above were selected as control variables in the final model, so that the final representation model was as follows:

$$\begin{aligned}\ln ruralincome &= \beta_0 + \delta_0 d2 + \beta_1 dB + \delta_1 d2 \cdot dB + \beta_2 \ln primary + \delta_2 \ln second \\ &+ \beta_3 \ln third + \delta_3 \ln fiscal + \beta_4 \ln population + \delta_4 \ln angriarea + \mu\end{aligned} \quad (4.1)$$

The items in the above equation are also consistent with the previous, where $d2$ is a time dummy variable (before and after the implementation of the policy), which takes a value of 0 to indicate the implementation of the policy and 1 to indicate after the implementation of the policy; dB is a dummy variable for whether an individual implemented the policy or not, which takes a value of 0 to indicate that the individual did not implement the policy, i.e. the control group, and 1 to indicate that the individual was affected by the policy, i.e. the effect group; and is an error term. and the rest of the moderate items are in logarithmic form for the control variables.

TABLE X shows the integration of the results of the regressions done following the previous method. From the corresponding terms in columns (1) and (6) of the numerical regression, it can be seen that the South-North Water Diversion Central Project had an adverse impact on farmers' net income, reducing it by RMB 211 and RMB 455.6 respectively. As can be observed from the corresponding terms in columns (2) and (7) of the whole segment analysis, the regression values after taking the logarithm are negative and both pass the test of significance level of 1%, indicating that the South-North Water Transfer Project has a negative effect of 0.272 percentage points and 0.281 percentage points on the net income of farmers in the water source area. In the segmented regressions, the regression values obtained using both types of segmentation methods were negative and highly significant.

Such regression results also confirm our conjecture that the construction of the South-North Water Transfer Central Line Project has a negative effect on the net per capita income of farmers in Shiyan, the water source area.

The regression coefficients for the value added of the secondary sector are also collated in TABLE X. The analysis suggests that the "feed back" effect of the secondary sector on agriculture is not significant,

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
July-August 2022 Page No. 725-751
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which confirms what was stated in Chapter 1 under "Agricultural Issues".

TABLE X. Collation of regression results

	Data regression	**Logistic regression**			
	Whole section returns		Segmented returns		
2004 as a node	2001~2004 2005~2013 (1)	2001~2004 2005~2013 (2)	2001~2004 2005~2008 (3)	2001~2004 2009~2011 (4)	2001~2004 2012~2013 (5R)
dudt	-211.0 (0.734)	-0.272*** (0.000)	-0.171*** (0.004)	-0.341*** (0.000)	-0.291** (0.015)
Second/lnsecond	-1.095 (0.563)	0.259*** (0.006)	0.207 (0.103)	0.321*** (0.008)	0.0788 (0.497)
2005 as a node	2001~2005 2006~2013 (6)	2001~2005 2006~2013 (7)	2003~2005 2006~2008 (8)	2003~2005 2009~2011 (9)	2003~2005 2012~2013 (R)
dudt	-455.6 (0.509)	-0.281*** (0.000)	-0.149*** (0.007)	-0.308*** (0.000)	-0.326** (0.048)
Second/lnsecond	-0.711 (0.683)	0.285*** (0.000)	0.0806 (0.262)	0.164 (0.111)	-0.0707 (0.617)

V. ONCLUSION AND COUNTERMEASURES

5.1 Conclusion

In this paper, a whole-section regression analysis is conducted on the relevant data values and log values from 2001 to 2013, using 2004 and 2005 as the construction nodes respectively. The coefficients of *dudt* in the whole-segment regression results are all positive, indicating that the South-North Water Transfer Project has stimulated economic growth in Shiyan. However, analysis of the specific values of the *dudt* coefficients shows that the stimulating effect of the construction of the South-North Water Transfer Central Line Project on the economic growth of the core water source area is not significant, and there is no significant poverty reduction effect.

The logit values were analysed in separate segment regressions according to two different segmentation approaches. The regression results for the two data sets show different trends: the first shows an "inverted U" trend, i.e. the regression results show a peak between 2009 and 2011; the second shows a continuous downward trend. The analysis suggests that the large-scale migration in Shiyan between 2009 and 2011, the transfer payments from the government during the migration process and the stimulation of the transportation, demolition and housing sectors by the migration, led to a growth in the economy of Shiyan during that period. In the following years, this 'bubble' stimulus quickly disappeared, resulting in a

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sharp decline in the regression results between 2012 and 2013. The 'inverted U' trend is therefore more realistic.

In the analysis of the impact of the South-North Water Transfer Project on rural net income per capita in the water source areas, the regression results are all negative and show strong significance. The decline in rural net income per capita caused by the construction of the Central Line Project has had a negative impact on economic development and poverty reduction in the core water source areas.

In summary, from an overall perspective, the South-North Water Transfer Central Line Project has stimulated economic growth and poverty reduction in Shiyan, but the extent of the impact is not significant. By stages, the positive impact of the Central Link Project on economic growth in the Shiyan area is weakening, and there is even a momentum of hindering economic development and negatively affecting poverty reduction in Shiyan.

5.2 Countermeasures for Pverty Rduction in Shiyan under Wter Surce Potection Cnstraints

Firstly, establishing a multi-dimensional linkage development mechanism

Shiyan's dual identity-as a core water source area for the South-North Water Diversion Project and a contiguous poverty alleviation area in the Qinba Mountains - puts Shiyan in a conflict between ensuring water quality and ecological security and developing the economy. Therefore, it is a challenge for Shiyan to reconcile the contradiction between poverty alleviation and water resources protection, and to take effective measures to achieve the dual objectives, so that poverty alleviation and development can be successfully implemented while water resources are also effectively protected. Coordinating the two development goals, finding a balance between them and establishing a multi-dimensional linkage development mechanism is the key to resolving the conflict.

The multi-dimensional linkage development mechanism mentioned here includes four aspects, the first is the linkage of water source protection work and poverty reduction work, from the industrial choice aspect of the solution of how to turn the conflict into unity; the second is the linkage of the water receiving area and the water source development, drinking water and thinking of the source, the water receiving area, especially Beijing and Tianjin and other developed areas have the responsibility and obligation to provide assistance to the water source area out of poverty; the third is the linkage of poverty reduction mechanism of the administrative regions within the poverty area. The fourth is the linkage mechanism between the Hubei Qinba Mountain concentrated contiguous poverty area and the Han River Basin Ecological and Economic Zone, to achieve docking and integration at the policy and planning levels, enhance the efficiency of resource allocation, and increase the effectiveness of economic development and poverty reduction.

Secondly, developing special green industries

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Shiyan is a mountainous city and a world-renowned centre of Taoist culture, with numerous mountain resources and distinctive cultural features. Some green industries, such as agriculture and forestry, are relatively well developed. Shiyan can be developed in depth in green industries, especially green agriculture and ecological and cultural tourism. By vigorously developing green industries and realising the gradual transformation of the economic development model, the number and proportion of some industrial enterprises, especially those that are more destructive to the water resources environment, can be reduced accordingly, thus alleviating water resources pollution and ensuring that the goal of water resources protection is also achieved while alleviating poverty and development. The focus of the development of green industries in Shiyan should be placed on the following four aspects.

(1) Development of green products

The Qinba Mountain area is a precious biological resource bank in China, with numerous characteristic resources to be developed. At present, Shiyan already has a variety of agricultural products sold all over the country, and the main ones that are famous are: walnuts, matou goats, wild grapes, Wudang mountain treasures, etc. However, compared to the varieties of resources it has, the product development efforts are not enough, and resources like Danjiang wild fish, tea leaves and green vegetables are yet to be developed in depth.

(2) Creating green brands

The Dan River water source and the Qinba Mountain Ecological Reserve are natural green brand symbols. For Shiyan's agricultural, forestry, fishery and water resources to be competitive and get rid of the embarrassing position of downstream supply, it is necessary to support leading enterprises to create their own green brands, during which the Shiyan government and people need to make every effort to cooperate in management, promotion and development.

(3) Development of green tourism

The diverse mountain resources, water resources and cultural resources of Shiyan provide a strong support for the development of its tourism industry, but the focus of tourism development lies in market development, scenic spot management and capital investment. (4) Promote the development of the new energy vehicle industry

(4) Promote the development of new energy automobile industry

Shiyan is a famous automobile city and can rely on its existing automobile industry base to vigorously develop the new energy automobile industry. Focusing on Shiyan Economic and Technological Development Zone, optimize the structure of automobile products in the zone, encourage key enterprises in the zone to develop automobile projects that do not rely on fossil energy such as hybrid and pure electric vehicles, create conditions to introduce domestic and foreign automobile industry giants to build new

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energy automobile projects in the zone, and strive to build a new energy automobile industry chain.

Third, increase ecological "soft" compensation for water sources

At present, most of the national, provincial and local poverty reduction policies tend to be financial compensation and subsidies, which have improved the production and living environment of the population in poor areas and raised their living standards to a certain extent, but the financial compensation has limitations in time and space and tends to breed corruption among the personnel involved in the financial control departments. The State and local authorities can consider increasing the ecological "soft" compensation for the water sources of the South-North Water Diversion Project in order to optimise the industrial layout of Shiyan and co-ordinate project arrangements, with emphasis on the following aspects.

(1) Market compensation for economic development

The South-North Water Diversion receiving area is located in the economically developed areas of Beijing, Tianjin and Hebei, where resources are relatively scarce. Market share, one is the financial can be part of the share of government material procurement directed to the water source, increase the local income of the district, the second is to develop preferential policies to encourage enterprises in the receiving area to invest the market to the water source, can adopt order-based production, agricultural super docking, direct supply and direct sales and chain management, annual directed to sign contracts with enterprises in the water source, to solve the local product sales problems.

(2) Technical compensation to promote the upgrading and transformation of traditional industries

The first is to give full play to the technological innovation advantage of the water-receiving areas, to transform Shiyan's traditional industries with technological innovation, especially breakthrough technological innovation, instead of brutal shutdown, to maintain Shiyan's economic support under the premise of ecological friendliness, and then explore new paths for the development of traditional industries; the second is to combine universities, to give full play to the resource advantage of universities in Beijing, Tianjin and Hebei regions and the province, to introduce the support of school research teams, to combine agriculture, science, education, industry, academia and research Combined, priority is given to the promotion of new varieties, new technologies and scientific and technological innovations with low energy consumption and low pollution in water sources; thirdly, the introduction of scientific and technological talents, encouraging technical investment, leading and founding professional cooperative enterprises with local characteristics in the form of technical shares, etc.

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