Water Resource and Regional Economic Growth Study Based on Panel Data

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Abstract: Empirical analysis to the relationship between water resource scarcity degree and economic growth were done by building relationship model between water resource scarcity degree and regional economic growth with provincial panel data of 30 provinces during 2000-2009. The analysis results show that, in water resource scarcity regions, the shortage of water resource is the key factor of restricting economic development. In order to alleviate the shortage of water resource and meet the needs of economic development to water resource, it is necessary to speed up the establishment of water right trading market and finally achieve the goal of water-saving and regulation of water resource by economic leverage. The specific countermeasures include: first, comprehensively considering the endowment difference of water resource when carrying out industrial planning and layout; second, speeding up the establishment of water right trading market and revising water-saving incentive mechanism; third, increasing fiscal transfer payment ability to the provinces of outputting water resource; fourth, strengthening industrial guidance, making moderate industrial transfer and population movement; fifth, paying attention to science, technology and education investment, to improve utilization efficiency of water resource.

Key words: Shortage of water resource, regional economic growth, panel data, endowment of water resource.

1. Introduction

China is a country with drought and water shortage. The water resources distribution in China is very unequal, mainly reflecting in: (1) the regional distribution of water resources is uneven and presents diminishing distribution from south to north; (2) the time distribution of water resources is uneven, and the exploitable quantity of surface runoff and groundwater in natural rare rainfall regions also is less, what cause great difference of water resource endowment in the regions; (3), uneven regional economic development and difference between water resource protection and utilization policy in regions intensify uneven distribution of water resources.

Nearly 20 years, northern part of the basin has become absolute water resource shortage from periodic water resource shortage affected by global climate change as well as uneven regional industry layout and population movement. Meanwhile, China’s water consumption and wastewater discharge still maintain a very high level, what causes water environment worsening. Less water resources, uneven distribution and serious water pollution make water resource shortage become the key factor of restricting regional economic development. Therefore, it is necessary to study the relationship between water resource and regional economic growth, to reveal the inner link between water resource shortage degree and regional economic growth, and provide guiding idea for regional economic development and industry layout.

2. Literature Review

In recent years, our scholars have carried out a lot of helpful exploration to the relationship between water resource and economic growth from different study perspectives by different research methods, and
the relevant research can be mainly divided into two kinds: one kind is to research the relationship between water resource and economic growth by a province or region as object. Gu and Wang [1] and others evaluated the relationship between water resource utilization and economic growth in Jiangsu Province during 2000–2009 from two perspectives of water resource consumption and water environment pressure by water footprint method; Le [2] carried out empirical research to the relationship between water resource pollution and economic growth in Jiangxi Province through building measurement model between economic growth and water resource pollution by relevant data between water resource pollution and economic growth in Jiangxi Province during 1990–2009, found that there is “U-type + inverted U-type” relationship between industrial wastewater discharge and economic growth in Jiangxi Province. Sun and Deng [3] researched constraint effect of water resource to economic growth during 1995–2010 in arid regions of Xinjiang on the basis of building regional translog production function model Sun and Deng [3]; Wu and Dong [4] researched temporal dynamic variables relationship between water resource utilization and economic growth in Shandong Province during 1990–2010 aiming at the situation of economic development and water resource endowment in Shandong, they found that, there is co-integration relationship between economic growth and industrial and domestic water consumption, and there is no long-term equilibrium relationship between agriculture and total water consumption in Wu and Dong [4]. The other kind is by all provinces in China as object to explore the relationship between water resource and economic growth under provincial perspective, but the research is less. Deng and Liu [5] used VAR (vector auto regression) model and carried out empirical analysis to long-term equilibrium and dynamic relationship between water resource utilization and economic growth in China during 1980–2007, they obtained the conclusions that there is long-term equilibrium relationship among economic growth and industrial water, domestic water and total water consumption, and there is not long-term equilibrium relationship between economic growth and agricultural water; Pan and Ying [6] built VAR model by provincial panel data during 1998–2009 to inspect and analyze inherent dependence and causality between water resource and agricultural economic growth, and the research found that, the effect of agricultural economic growth to water resource has significant regional difference.

To conclude, with rapid growth of China’s economy, the utilization of water resources has become the important factor of affecting economic development, but conversely, economic growth also intensifies the shortage of water resources. From regional economic level, this paper analyzes the relationship between water resource shortage and the factors of variable of affecting regional economic growth, investment capital, industrialization degree and education investment, etc. and proposes corresponding countermeasures.

3. Modeling and Index Selection

Considering data availability, the paper uses water resource shortage degree to evaluate utilization degree of water resource in the regions. Needing to consider the information of regional economic development water resource consumption and regional water resource ownership when selecting data to evaluate water scarcity. Zhang and Huang [7] selected four indexes of water resource self-sufficiency rate, per capita water footprint, resource shortage degree and GDP/unit for shortage degree of water resource, the four indexes will be used as evaluation indexes of water resource shortage degree. In this paper, the shortage degree of water resource is measured only by water resource shortage degree index. The water resource shortage degree can be expressed by the specific value of total water footprint (total water footprint of a region is equal to the sum of real water and virtual water) and available water resources.
According to economic growth convergence theory, referred to research achievements of Wang [8], this paper builds regression model, which is suitable for panel data and reflects the relationship between water resource shortage and regional economic growth:

$$\ln(\frac{Y_t}{Y_{t-1}}) = \beta_0 + \beta_1 \ln(Y_{t-1}) + \beta_2 S_i + \beta_3 Inv + \beta_4 Ind + \varepsilon_i$$

(1)

In which, annual growth rate of GDP is regarded as explained variable, \(i\) means section unit of provinces, \(S\) means the shortage degree of water resource, \(\beta, \partial\) both represent regression coefficient, \(\varepsilon\) represents regression error. In which, annual growth rate of GDP is regarded as explained variable, \(i\) means section unit of provinces, \(S\) means the shortage degree of water resource, \(\beta, \partial\) both represent regression coefficient, \(\varepsilon\) represents regression error. The main factors affecting GDP, such as: capital investment, industrialization level and education level are expressed respectively by \(Inv, Ind\) and \(Edu\). Capital investment variable data is expressed by specific value of a region’s social fixed assets investment and GDP; industrialization level variable data is replaced by the specific value of region’s manufacturing total fixed assets investment in region’s total fixed assets investment; the attention degree of education level is measured by specific value of education expenditure in GDP.

In order to reflect the effectiveness of data and ensure the unity of sample data and overall data, the author eliminates the factors of variable data whose caliber is inconsistent and instead, uses series data of 30 provinces (excluding Tibet data) of provincial panel data during 2000-2009. In the paper, the water resource data of 2002-2009 is from “China Statistical Yearbook”, and the water resource data of 2000-2001 is calculated through time series. In the paper, the economic data of 2000-2009 is from “China Statistical Yearbook” and ever economic and financial research database.

### 4. Empirical Results

Assuming that simply use current time series data to do empirical research will have certain deviation due to sample limit. However, the empirical research by panel data can not only solve the limit of insufficient-sample, and improve the precision of model estimation, but also better analyze economic relationship among variables.

Cross-section weighted regression (cross section weights) method is more suitable for this model because the regression has heteroscedasticity. The dependent variable is the ratio of adjacent GDP. Five independent variables (\(lngdp_{t-1}, s, inv, ind, Edu\)) use constant parameter model, namely, do regression analysis by cross-section weighted regression (cross section weights) method. The regression model is:

$$\ln(\frac{Y_t}{Y_{t-1}}) = \hat{\beta}_0 + 0.0986 \ln Y_{t-1} - 0.00955 + 0.0195 Inv + 0.0179 Ind + 0.1237 Edu$$

(2)

The more * shows, the better significant relationship is. Like -6.15*** means that this factor is the most negative relevant correlation factor.

The regression coefficients of the mode meet theoretical expectation: If coefficient of water resource shortage degree is negative, it shows that the shortage is important factor of restricting economic development and has a negative impact on economic growth; if the symbols of industrialization, capital accumulation and education expenditure are positive, it shows that all these variables play the role of promoting economic growth. The effect of earlier GDP and water resource shortage degree to regional economic growth is significant, but the effect of latter three variables is not significant. The results of regression analysis are shown in Table 1.

### 5. Conclusions

#### 5.1 Water Resource Shortage—Important Factor of Restricting Economic Development

Rapid growth of China’s economy and movement of population intensify the unbalanced growth of demand for water. The shortage of regional water resource is more severe due to the limited water resource,
Table 1 GLS regression results of provincial panel data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. E</th>
<th>Statisti</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.098652</td>
<td>0.019208</td>
<td>5.136019</td>
<td>0.0000</td>
</tr>
<tr>
<td>LNDP0</td>
<td>0.004860</td>
<td>0.002104</td>
<td>2.310428</td>
<td>0.0216</td>
</tr>
<tr>
<td>S</td>
<td>-0.009546</td>
<td>0.001553</td>
<td>-6.145447</td>
<td>0.0000</td>
</tr>
<tr>
<td>INV</td>
<td>0.019454</td>
<td>0.018285</td>
<td>1.063911</td>
<td>0.2882</td>
</tr>
<tr>
<td>IND</td>
<td>0.017863</td>
<td>0.018751</td>
<td>0.952642</td>
<td>0.3416</td>
</tr>
<tr>
<td>EDU</td>
<td>0.123656</td>
<td>0.177673</td>
<td>0.695977</td>
<td>0.4870</td>
</tr>
</tbody>
</table>

the uneven spatial and temporal distribution, polluted water resource, low water utilization efficiency and waste of resource, etc. In addition, several water users with large consumption have to locate in water shortage area as some regions fail to comprehensively consider the restriction of water resources when doing industry planning. Bad results like exceeding carrying capacity of water resource and making the contradiction between water resource shortage in the region and rapid development of economy obvious happened. Therefore, water resource shortage and water quality deterioration become the bottleneck of restricting regional economic development.

5.2 Adjusting Unsound Systems on Endowment Difference of Water Resource

Economic developed regions often need more water resource due to gathering a lot of money, population and industry. Endowment difference of water resource can be adjusted by using economic strategy, like inputting water resource from the regions with rich water resources when the water resource is short. However, the output power of regions with rich water resources is insufficient due to the unsound systems of water right trading market, water resource compensation system and water pollution emission right. Therefore, the output power is insufficient from regions which are rich in water resource to water scarcity region.

5.3 Supporting Further Economic Development of Region with Accumulation of Early Development of Region

Although the effect of regional fund, education, science and technology’s investment to regional economy is positive, it need a process of long time accumulation. The role to promote regional economic growth is significant when capital investment, industrialization level and education investment are accumulated to certain degree, namely, the effect of early GDP to subsequent economic growth is obvious.

6. Suggestions

6.1 Needing to Comprehensively Consider Endowment of Water Resource When Doing Industry Planning and Layout

Governments should determine total pollution control and environmental carrying capacity of waters according to water function area division when doing regional overall macro planning, overall layout and setting specific function and development direction for cities.

6.2 Speeding up the Establishment of Water Rights Trading Market and Perfect Water-Saving Incentive Mechanism

Our state clearly puts forward to build resource conservation and environment friendly society. Technically, the building of water-saving society should build water-saving and anti-pollution society.

6.3 Increasing Fiscal Transfer Payment Degree to Provinces of Outputting Water Resource

First, it is necessary to increase longitudinal fiscal subsidies by transferring payment from center authorities to provinces of outputting water resource. Second, government should build water resource
protection fund, accept support funding from organizations and local or international enterprises, non-government organizations and individual.

6.4 Strengthening Industry Guidance and Moderately Carry out Industry and Population Movement

It is important to reduce water resource pressure in water shortage regions to carry out technology innovation of traditional industry. It is also a good idea to actively introduce foreign high-tech enterprise and fully play multiplier role of high-tech enterprise in industrial structure upgrade.

6.5 Paying Attention to Science, Technology and Education’s Investment, to Improve Utilization Efficiency of Water Resource

The government pays attention to comprehensive application of intelligence and technology resources, and increases science and technology investment to do reasonable technological transformation to efficient utilization and recycling of water resource. The enterprises should enhance communication and cooperation with scientific research institutions, colleges and universities, in order to jointly build research and development platform and solve problems.

Reference


