Research on the Correlation between Water Resources Utilization and Economic Growth
-- Based on VAR Model

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Abstract
This paper chooses the data of water use and economic development in China from 1997 to 2016, constructs the VAR model with data, tests the stability of variable data, and then performs Granger causality test, and adopts generalized impulse response function to analyze the interaction between variables. and then further use the variance decomposition to examine the long-term equilibrium relationship between China's economic growth and the use of water resources and dynamic characteristics. The empirical results show that there is a one-way causal relationship and a long-term dynamic relationship between water resource utilization and economic growth. The cumulative unit impact of economic growth on total water consumption, industrial water, and domestic water consumption is positive, and the cumulative unit impact of agricultural water consumption is negative. On the other hand, the cumulative impact of water use on economic growth is positive. In recent years, with China's economic development, domestic water consumption has increased significantly, and industrial water consumption has also been continuously increasing, while agricultural water consumption has remained unchanged or even has a downward trend. Economic growth has a greater impact on the forecast variance of water resources utilization. Agricultural water consumption has a certain impact on the forecast variance of economic growth. Total water consumption, industrial water and domestic water consumption contribute little to the forecast variance of economic growth. This shows that China should increase the utilization rate of industrial water and domestic water, save water, and develop and utilize water resources rationally and efficiently.

Keywords
Economic Growth; Water use; VAR model.

1. INTRODUCTION
Environmental resources and socio-economic development are a pair of contradictions. Socio-economic development depends on the foundation of environmental resources, and environmental resources determine the upper limit of socio-economic development. A country's economic development level must be within the sustainable range of environmental resources in order to achieve sustainable social and economic development. Water is the source of life, an indispensable resource for human survival, and a basic material for social and economic development. The history of human development is also a history of using water resources. With the rapid development of society and rapid population growth, water resources have become a basic natural resource and a strategic economic resource. It is a bottleneck for the development of modern society and severely restricts the economic development of some countries and regions. From the perspective of the sustainable development of water resources,
it is necessary to maintain the persistence and continuity of water resources, but also to allow water resources to meet the needs of social and economic development as much as possible. China is a severely water-deficient country. Clarifying the relationship between water resource utilization and economic growth has important practical significance for promoting the coordinated development of China’s economy and ecology.

2. LITERATURE REVIEW

In the 1990s, with the increasing shortage of water resources, the contradiction between economic development and water resources utilization gradually became prominent, and water resources research at home and abroad began to gradually rise. The United Nations Commission on Sustainable Development has launched a special study on water resources management. Foreign scholars have gradually changed from qualitative research to quantitative research. Howe has been studying the water use problems in cities with water scarcity in the United States for a long time. He has conducted a qualitative analysis of the relationship between water use and economic growth, and studied the correlation between the two. He believes that there is a relationship between efficient use of water resources and acceleration of economic growth. Brown established a model to quantitatively analyze the impact of water scarcity on China’s economic growth.

The management of water resources in China basically began in the same period. The main body of water resources research in China in the early days was water conservancy workers, who were mainly responsible for statistics of water resources in China. With the rapid economic development, the use of water resources has increased sharply, and this problem has attracted more and more scholars’ attention. Scholars such as Feng Shangyou and Fu Xi introduced the concept of "water resources management system" into the hydrological research community, and further put forward the viewpoint of "sustainable water resources management". At present, domestic scholars mainly conduct research on the supply and demand relationship of water resources, water resources allocation, water resources carrying capacity, and sustainable utilization of water resources. Scholars such as Deng Chaohui, Liu Yang, etc., built a VAR model and found that there is a long-term dynamic equilibrium relationship between China’s economic growth and water resources utilization. Lu Ning used water resources data from 52 cities in China to quantitatively analyze the relationship between water use pressure and economic growth in China by establishing a measurement model; Based on the LHR computable general equilibrium model, Wang Keqiang and Li Guojun analyzed the impact of China’s agricultural water resources policy on the agricultural economy. China has a vast territory, complex topography and landforms in various regions, and there are serious imbalances in the distribution of water resources in time and space. Scholars such as Zhang Jihui conducted statistics on the Gini coefficient of economic development factors such as water resources and population, area and GDP in various regions, and studied the matching relationship between the distribution, allocation and economic development factors of China’s water resources. Guo Wei explained the current situation of water shortages in China based on China’s water resources statistics for many years. He suggested increasing investment in water conservancy construction, building water storage projects, water diversion projects, and rationally developing groundwater. At the same time, a large number of scholars have determined from using water to price In-depth study of the problem from perspective: Zhong Shuai and Qin Changhai used water resources data to construct a CGE model, and quantitatively analyzed the impact of water price changes and water price reforms on water resources utilization and national economic development; Wang Fei analyzed the VAR model The relationship between economic output, water consumption and corresponding water prices is discussed, and the use of water price levers for water resources allocation is proposed. Numerous research results
show that increasing water prices can significantly control water consumption, and has a positive effect on alleviating water shortages and reducing water waste.

3. CURRENT STATUS OF WATER RESOURCES UTILIZATION IN CHINA

Since the founding of New China, China has gradually established a relatively complete flood control and disaster reduction system, farmland irrigation system, and urban and rural water supply system, which has improved the ability of agriculture to resist floods and droughts, effectively improved agricultural production conditions, and safeguarded and promoted China’s social economy. The development of the country has improved the people’s living standards. However, the problem of water resources has been plagued by China’s economic development and has not been fundamentally resolved. It has become an important factor affecting the sustainable development of China’s economy and society. China is a severely water-deficient country. As of 2016, China’s total water resources were 3246.64 billion cubic meters, accounting for about 6% of the world’s water resources, ranking fourth in the world, second only to Brazil, Russia, and Canada; The population is large, and the per capita water resources are about 235.4 billion cubic meters, which is only a quarter of the world per capita level. It is listed by the United Nations as a country with extremely scarce per capita water resources. At the same time, the temporal and spatial distribution of water resources in China is uneven, with 669 in the country. Nearly 400 of the cities are in a state of water shortage, and the trend of deterioration of the water environment has not been effectively curbed. The country’s soil erosion area was 3.67 million square kilometers, accounting for 38.3% of the country’s land area. Nearly half of the rivers in the country and 90% of urban waters are polluted to varying degrees. The deterioration of the hydrological environment has destroyed the ecosystem and further aggravated the contradictions caused by the shortage of water resources. With the continuous increase of China’s population, the expansion of economic aggregates and the acceleration of the process of urbanization, water resources have become an important constraint on China’s sustainable development and are fundamental, overall and strategic for achieving economic and social development goals in the new era. problem.

According to the above statistical data, we can see that the total amount of water resources in China fluctuates greatly. Especially in 1998, the total amount of water resources reached 3401.7 billion cubic meters. The reason for the fluctuation of water volume is mainly related to
the weather of that year. The amount of rainfall will vary. It directly affects the total amount of water resources in our country. However, China’s total water consumption has not changed much. Generally speaking, it is in a slow upward process, but the growth rate is gradually decreasing, and it will even show a steady state and negative growth after 2010. This is in line with the normal laws of economic development. In the initial stage, with the continuous expansion of economic aggregates, the water consumption will also continue to increase. However, with the update of production equipment and the improvement of the use of technology, the awareness of water saving has increased. In terms of factors, it is entirely possible to achieve zero or even negative growth of water resources.

In China’s total water consumption, it is mainly divided into three parts: "agricultural water, industrial water and agricultural water". Agricultural water always occupies the dominant position, which is determined by China’s economic structure and the natural characteristics of agricultural water. However, the proportion of agricultural water consumption has dropped significantly. In 1997, the proportion of agricultural water consumption accounted for 71% of the total water use. By 2007, it had dropped to 62%. Since then, the proportion of agricultural water consumption has been within a small fluctuation range; Under the circumstances, industrial water and domestic water use increased accordingly. Industrial water consumption has been on the rise until 2007, rising from 20.2% in 1997 to 24.1%, but it has declined slightly since then. Domestic water has been steadily rising, which may be related to the increase in the total population of our country and the improvement of living standards.

4. VARIABLE SETTING AND RESEARCH METHODS

4.1. Variable Setting

Aiming at the two research objects of economic growth and water resource utilization, this paper adopts corresponding representative variables to describe. GDP (gross domestic product) refers to the market value of all kinds of products and services produced by resident units in a country or region in a certain period of time. GDP is the core indicator of national economic accounting and a measure of the overall economy of a country or region. This article selects GDP (unit: 100 million yuan) as a measure of economic growth; the use of water resources selects total water consumption (TAL), agricultural water consumption (AGR), and industrial water consumption (IND) according to actual usage classification.), and domestic water consumption (LIV) as a measure (unit: 100 million cubic meters). China’s water resources report has only been officially compiled in 1997. In view of the availability and reliability of existing data, the time range of the data selected in this paper is from 1997 to 2016. Water resource utilization data is obtained by consulting "China Water Resources Bulletin", "China Water Conservancy Yearbook" and "China Statistical Yearbook", and GDP data is selected from "China Statistical Yearbook".

In this paper, five sets of time series data have been obtained. Taking into account the volatility of the data and the possible heteroscedasticity, the time series data is logarithmized to obtain five sets of new data. This article names the data of GDP, total water consumption, agricultural water consumption, industrial water consumption, and domestic water consumption after logarithmic processing as: "LNGDP, LNTAL, LNAGR, LNIND, LNLIV)."

4.2. Research Methods

The traditional econometric method is a model that describes the relationship between variables based on economic theory. However, economic theory is usually not enough to provide a rigorous explanation for the dynamic relationship between variables, and endogenous variables can appear either on the left end of the equation or on the right end of the equation,
making estimation and inference more complicated. VAR is a model that uses non-structural methods to establish the relationship between various variables.

\[ X_t = c + \sum_{j=1}^{p} A_j X_{t-j} + \varepsilon_t \]

Among them: \( X_t \) is the vector formed by the time series; \( c \) is the constant term; \( p \) is the autoregressive lag order; \( A_j \) is the time series coefficient matrix; \( \varepsilon_t \) is the white noise sequence vector, which satisfies \( E(\varepsilon_t) = 0 \) and the mean value of the error term is 0, \( E(\varepsilon_t\varepsilon'_{t-k}) = \Omega \), the covariance matrix of the error term is \( \Omega \), \( E(\varepsilon_t\varepsilon'_{t-k}) = 0 \), there is no autocorrelation in the error term.

This paper establishes a VAR model composed of 4 water resources indicators (total water consumption, agricultural water consumption, industrial water consumption, domestic water consumption) and economic growth indicators (GDP), and analyzes the Chinese economy through impulse response and variance decomposition. Empirical research on the relationship between growth and water use. Since the time series may have a deterministic trend, it will often cause "false regressions", which will mislead the analysis results. Therefore, before data analysis, it is necessary to perform ADF (Augmented Dickey Fuller) stationarity test on five groups of time series.

In order to study the long-term dynamic relationship between economic growth and water resources utilization, this paper intends to use the impulse response function method to describe the long-term dynamic interaction between water resources utilization and economic growth. The impulse response function (IRF) describes the response of an endogenous variable to errors, that is, adding a standard deviation to the disturbance term will affect the current and future values of the endogenous variable. It is defined as:

\[ I_s(n, \varepsilon_t, t-1) = E(x_t+n|\varepsilon_{t+k} = \delta_k, t-1) - E(x_t+n|t-1) \]

In the formula, \( \delta_k \) represents the shock from the k-th variable, \( n \) is the number of shock response periods, and \( t-1 \) represents all the information that can be obtained when the shock occurs. The IRF value of n-period shocks is required, considering the difference caused by the expected value of \( x_{t+n} \) by \( \delta_k \) shocks.

Different from the impulse response function method, the VAR prediction variance decomposition method gives the relative importance between the variables. The core of the method is to decompose the Mean Square Error (MSE) error of each endogenous variable in the system according to its cause. It is the m parts associated with each equation, so as to understand the relative importance of each information to the endogenous variables of the model. The s-step prediction error of the VAR(p) model is:

\[ \varepsilon_{t+s} + \varphi_1\varepsilon_{t+s-1} + \varphi_2\varepsilon_{t+s-2} + L + \varphi_{s-1}\varepsilon_{t+1} \]

Its mean square error (MSE) is:

\[ \Omega + \varphi_1 \Omega \varphi_1' + L + \varphi_{s-1} \Omega \varphi_{s-1}' = pp' + \varphi_1 pp' \varphi_1 + L + \varphi_{s-1} pp' \varphi_{s-1} \]

In the formula, \( pp' = \Omega \), according to formula (6), the predicted mean square error of any endogenous variable can be decomposed into the impact contribution value of each variable in the system, and then the relative importance of each variable impact can be calculated. That is, the proportion of the contribution of the variable. This article intends to use the VAR forecasting variance decomposition method to measure the degree of influence between economic growth and water resource utilization.
5. **EMPIRICAL ANALYSIS**

5.1. **Stationarity Test**

The establishment of the VAR model is based on the stability of the data. If the data is not stable, it may lead to false regression of the results, and the statistical results will be meaningless. Therefore, it is necessary to test the stationarity of the data, that is, whether there is a unit root. This paper conducts ADF (Augmented Dickey Fuller) stability test on five sets of data including gross domestic product (LNGDP), total water consumption (LNTAL), agricultural water consumption (LNAGR), industrial water consumption (LNIND), and domestic water consumption (LNLIV). The test results are shown in the table 1:

<table>
<thead>
<tr>
<th>Variable sequence</th>
<th>ADF statistics</th>
<th>10% confidence level</th>
<th>Is it stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDP</td>
<td>-1.44348</td>
<td>-2.68133</td>
<td>No</td>
</tr>
<tr>
<td>dlnGDP</td>
<td>-2.780443</td>
<td>-2.673459</td>
<td>Yes</td>
</tr>
<tr>
<td>lnTAL</td>
<td>-0.776292</td>
<td>-2.655194</td>
<td>No</td>
</tr>
<tr>
<td>dlnTAL</td>
<td>-5.353299</td>
<td>-2.660551</td>
<td>Yes</td>
</tr>
<tr>
<td>lnAGR</td>
<td>-1.297677</td>
<td>-2.660551</td>
<td>No</td>
</tr>
<tr>
<td>dlnAGR</td>
<td>-6.79732</td>
<td>-2.660551</td>
<td>Yes</td>
</tr>
<tr>
<td>lnIND</td>
<td>-1.413175</td>
<td>-2.655194</td>
<td>No</td>
</tr>
<tr>
<td>dlnIND</td>
<td>-3.080275</td>
<td>-2.660551</td>
<td>Yes</td>
</tr>
<tr>
<td>lnLIV</td>
<td>-1.780745</td>
<td>-2.655194</td>
<td>No</td>
</tr>
<tr>
<td>dlnLIV</td>
<td>-3.574749</td>
<td>-2.660551</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: d represents the first-order difference

According to the test results, below the 10% confidence level, LNGDP, LNTAL, LNAGR, LNIND, and LNLIV are all non-stationary data. But after the first-order difference, the five sets of data all become stationary series. Therefore, there may be a long-term equilibrium relationship among LNGDP, LNTAL, LNAGR, LNIND, and LNLIV, and we can use this data to establish a VAR model.

5.2. **VAR Model Construction**

The VAR model is used to measure the dependence of the dependent variable on one or more explanatory variables, so it can be used to analyze and predict macroeconomic activities and the impact of external factors on the economy. The research object of this paper is the correlation between China's economic growth and water resources utilization. According to the results of the stability test above, the VAR model will be established using gross domestic product (LNGDP) and total water consumption (LNTAL), agricultural water consumption (LNAGR), industrial water consumption (LNIND), and domestic water consumption (LNLIV). The specific model settings are as follows:

\[
\ln GDP_t = \alpha + \sum_{i=1}^{p} \beta_i \cdot \ln GDP_{t-i} + \sum_{j=1}^{p} \beta_j \cdot \ln TAL_{t-j} + \sum_{m=1}^{p} \beta_m \cdot \ln AGR_{t-m} + \sum_{n=1}^{p} \beta_n \cdot \ln IND_{t-n} + \sum_{k=1}^{p} \beta_k \cdot \ln LIV_{t-k} + \epsilon_t
\]

In the formula, t is the observation period, p is the lag order, and \( \alpha, \beta_i, \beta_j, \beta_m, \beta_n, \) and \( \beta_k \) are all estimated parameters, which measure the influence of explanatory variables on dependent variables. \( \epsilon_t \) is a random disturbance term. Use Eviews to process the data. Each variable in the model is processed by logarithm and difference. From the fitting degree of the equation and the significance of the coefficient, the AIC criterion including the lag order...
judgment is comprehensively considered, and the largest of each variable is selected. The lag order is 2.

Table 2. Regression statistics

<table>
<thead>
<tr>
<th></th>
<th>LNGDP(-1)</th>
<th>LNTAL(-1)</th>
<th>LNA GR(-1)</th>
<th>LNILV(-1)</th>
<th>LNILV(-2)</th>
<th>LNILV(-3)</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNGDP(-2)</td>
<td>0.463007</td>
<td>0.108776</td>
<td>0.332587</td>
<td>0.727051</td>
<td>0.16703</td>
<td>0.1499</td>
<td>0.2127</td>
</tr>
<tr>
<td>LNTAL(-2)</td>
<td>-0.036908</td>
<td>-0.130815</td>
<td>0.656240</td>
<td>-0.998486</td>
<td>-0.308192</td>
<td>-0.09049</td>
<td>-0.41600</td>
</tr>
<tr>
<td>LNA GR(-2)</td>
<td>0.217272</td>
<td>0.011418</td>
<td>0.680440</td>
<td>-0.452256</td>
<td>-0.252562</td>
<td>0.41033</td>
<td>0.86156</td>
</tr>
<tr>
<td>LNILV(-2)</td>
<td>1.084186</td>
<td>0.279542</td>
<td>0.282316</td>
<td>1.496247</td>
<td>0.169401</td>
<td>0.42348</td>
<td>2.56020</td>
</tr>
<tr>
<td>LNILV(-3)</td>
<td>0.793256</td>
<td>0.387820</td>
<td>0.163446</td>
<td>0.013701</td>
<td>0.097351</td>
<td>0.42111</td>
<td>1.85727</td>
</tr>
<tr>
<td>LNILV(-4)</td>
<td>0.283025</td>
<td>-0.131088</td>
<td>-0.810960</td>
<td>-0.606233</td>
<td>0.528267</td>
<td>0.50462</td>
<td>0.56036</td>
</tr>
<tr>
<td>C</td>
<td>-7.91763</td>
<td>6.055567</td>
<td>10.38739</td>
<td>12.38326</td>
<td>8.611059</td>
<td>0.45849</td>
<td>2.62419</td>
</tr>
</tbody>
</table>

According to the table 2, we can get the parameter estimation value of the VAR model, and write the VAR estimation model equation

\[
\ln GDP = 0.297 \ln GDP(-1) + 0.463 \ln GDP(-2) - 0.6356 \ln TAL(-1) - 0.1499 \ln TAL(-2) + 0.2127 \ln AGR(-1) + 0.4186 \ln AGR(-2) + 1.0842 \ln IND(-1) - 0.7933 \ln IND(-2) + 0.283 \ln LIV(-1) + 1.2058 \ln LIV(-2) - 7.01776
\]

For the VAR model, if the reciprocal of the absolute value of all the roots of the VAR model is less than 1, that is to say, all the values fall in the unit circle, it indicates that the VAR model is stable. Conversely, if all the values do not fall in the unit circle, the model estimation is unstable. According to the table below, all values are located in the unit circle, indicating that the VAR model estimation is very effective.
5.3. Granger Causality Test

Granger causality reflects the correlation between the current value of a variable and the past value of other variables. If the lagged term of one variable can affect another variable, then there is a Granger causality between the two. Use Eviews to perform Granger causality test on the variables in the model. According to the interval length of the data, the lag order selected in this paper is 2.

**Table 3. Dependent variable: LNGDP**

<table>
<thead>
<tr>
<th>Excluded</th>
<th>Chi-sq</th>
<th>df</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNTAL</td>
<td>0.997260</td>
<td>2</td>
<td>0.6074</td>
</tr>
<tr>
<td>LNAGR</td>
<td>0.742748</td>
<td>2</td>
<td>0.6998</td>
</tr>
<tr>
<td>LNIND</td>
<td>6.673527</td>
<td>2</td>
<td>0.0356</td>
</tr>
<tr>
<td>LNLIIV</td>
<td>8.583290</td>
<td>2</td>
<td>0.0137</td>
</tr>
<tr>
<td>All</td>
<td>25.01674</td>
<td>8</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

According to the data in the table:

Industrial water consumption (LNIND) and domestic water consumption (LNLIIV) are Granger factors of gross domestic product (LNGDP), while total water consumption (LNTAL) and agricultural water consumption (LNAGR) are not gross domestic product (LNGDP) Granger in. On the contrary, gross domestic product (LNGDP) is not a Granger factor of any one of total water consumption (LNTAL), agricultural water consumption (LNAGR), industrial water consumption (LNIND), and domestic water consumption (LNLIIV). It can be seen that there is a one-way Granger causality between GDP and several variables of water consumption. GDP has no significant impact on the use of water resources, but in turn the use of water resources can affect economic growth, indicating that water resources have a restrictive effect on economic growth. Therefore, it is necessary to use water resources rationally and improve the efficiency of water use, so as to promote sound and rapid economic development.

5.4. Impulse Response Analysis

(1) The dynamic relationship between economic growth and total water consumption
The relationship between economic growth and total water consumption is shown in the figure 3: From the perspective of the impact of economic growth on total water consumption, the initial response value is 0, that is, the unit impact of total water consumption has no effect on economic growth. The progress of the second period began to be negative (-0.002625) and showed a decreasing trend, and the response value in the third period was -0.014485. But when the sixth period is reached, the impact of economic growth on total water consumption remains almost unchanged, stabilizing at around -0.04. The cumulative value of the impact of total water consumption on economic growth is -0.303885, and the overall impact is negative, indicating economic growth. Constrained by total water consumption. As far as the unit impact of LNGDP on LNTAL is concerned, the current response value of LNTAL is 0.001894, the response value of the second phase reaches its peak (0.008325), and it begins to decline in the fourth phase (0.008029), and the response value gradually tends to zero. The cumulative response value of LNTAL is 0.047227, indicating that economic growth can promote total water consumption.

(2) The dynamic relationship between economic growth and agricultural water consumption

As can be seen from the figure 4, the response value of economic growth to the impact of agricultural water use in the current period is 0, and then continues to decline as the number of periods increases. After reaching the sixth period (-0.049763), the response value begins to remain basically stable, and the overall cumulative The shock response value is -0.385321, indicating that agricultural water use has a negative impact on economic growth. The impact response trend of agricultural water use to economic growth fluctuates greatly. The initial response value (-0.010102) is negative, but the response value in the second period (0.000934) is positive. And it has been fluctuating since then, with a cumulative shock response value of -
0.002953, indicating that economic growth has had a negative constraint on agricultural water use.

(3) The dynamic relationship between economic growth and industrial water consumption

![Figure 5. Impulse response results](image)

It can be seen from the figure 5 that the shock response of economic growth to industrial water is opposite to that of agricultural water. The current shock response value is 0, and the second shock response value is 0.016287. The overall trend is upward, and the upward trend is relatively flat. The cumulative shock response value is 0.324651, which shows that industrial water has a positive effect on economic growth, and industrial water will promote economic growth. On the other hand, the impact response of industrial water to economic growth is a process of rising first and then falling. The initial response value is 0.023947, and the third-stage impact response reaches the maximum value of 0.027791. The overall response value is positive, and the cumulative impact response value is 0.235108, indicating that economic growth also has a positive effect on industrial water use, and the two promote each other.

(4) The dynamic relationship between economic growth and domestic water consumption

![Figure 6. Impulse response results](image)

As shown in the figure 6, the impact response value of economic growth to domestic water is on the rise, the current value is 0, after the fifth period (0.054051), it is close to a stable trend, and the maximum impact response value is 0.057567 in the seventh period. The overall impact response cumulative value is 0.429838, which shows that domestic water has a positive effect on economic growth, which is similar to the pulse analysis result of industrial water. The impact
of domestic water on economic growth is a decreasing curve, reaching the highest value in the current period (0.008828), and gradually approaching zero as the number of periods increases. The overall cumulative shock response value is 0.063028, which shows that economic growth has a positive effect on domestic water use.

5.5. Analysis of Variance Decomposition of Water Resources Utilization and Economic Growth

When checking the dynamics of the VAR system, the variance decomposition gives the proportion of changes in the dependent variable when it is impacted by itself and other variables. Of course, the impact of the i-th variable will directly affect this variable, and the dynamics of the VAR model can also be used. The structure transmits this impact to other variables in the system. This article uses Eviews to decompose the variance of the constructed VAR model. The variance solution determines the extent to which the variance error predicted by the variable GDP over the previous s period (s=1, 2, 3...) can be explained by the changes in each water resource utilization variable.

Table 4. Variance Decomposition of LNGDP

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>LNGDP</th>
<th>LNTAL</th>
<th>LNAGR</th>
<th>LNIND</th>
<th>LNLIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.02487</td>
<td>100.000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.00000</td>
</tr>
<tr>
<td>2</td>
<td>0.09815</td>
<td>86.25402</td>
<td>4.78576</td>
<td>3.06929</td>
<td>5.23756</td>
<td>6.65340</td>
</tr>
<tr>
<td>3</td>
<td>0.08080</td>
<td>67.56578</td>
<td>2.57777</td>
<td>19.36787</td>
<td>8.09501</td>
<td>2.49096</td>
</tr>
<tr>
<td>4</td>
<td>0.08578</td>
<td>56.99374</td>
<td>3.30704</td>
<td>32.04902</td>
<td>5.20665</td>
<td>2.39509</td>
</tr>
<tr>
<td>5</td>
<td>0.11360</td>
<td>53.06835</td>
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According to the table 3, it can be seen that the forecast variance of the gross domestic product (LNGDP) is mainly explained by itself, from 100% in the first period to 86% in the second period, with an average contribution of 55.2%. Agricultural water consumption (LNAGR) also plays a large role in explaining the forecast variance of gross domestic product (LNGDP). The proportion is close to 43% in the later stage, and the average contribution is 30%. The other three variables, total water consumption (LNTAL), industrial water consumption (LNIND), and domestic water consumption (LNLIV), contribute 4.6%, 4.6%, and 5.65 to the forecast variance of gross domestic product (LNGDP), respectively. It can be seen that agricultural water use has a greater impact on economic growth, while several other water resources variables have little effect on economic growth. This also reflects that economic growth is determined by many macro factors, and the use of water resources only affects economic growth. One aspect of economic development.

On the other hand, this article also counts the interpretation of the forecast variance of gross domestic product (LNGDP) to the other four variables: the average contribution of gross domestic product (LNGDP) to the forecast variance of total water consumption (LNTAL) reaches 18%, The average contribution of the variance of the forecast for agricultural water consumption (LNAGR) reached 23.5%. The average contribution of LNGDP to the forecast variance of industrial water consumption (LNIND) and domestic water consumption (LNLIV) was 44% and 25.1%, respectively, which exceeded the forecast variance of agricultural water consumption. It can be seen from this that with the rapid economic growth, the scale of
Industrial production continues to expand, the level of urbanization continues to increase, and water resources are over-exploited and utilized. Industrial water and domestic water have become the main reasons for the increase in total water consumption.

6. CONCLUSION

This paper uses the economic development and water resource utilization data of China from 1997 to 2016 to establish a VAR model to test the stability of the data; Adopting Granger causality test, impulse response and variance decomposition to conduct empirical analysis, study the dynamic response relationship between water resource utilization and economic development, and draw the following conclusions:

(1) According to the Granger causality test, it can be concluded that there is a one-way causal relationship between water resource utilization and economic growth, in which industrial water and domestic water are the Granger cause of economic growth, indicating that changes in water resources will directly affect economic development and restrict the speed of economic development. Through the impulse response, it can be found that there is a long-term dynamic relationship between water resource utilization and economic growth. The cumulative impact of economic growth on total water consumption, agricultural water, industrial water and agricultural water consumption is negative. This shows that water resources have obvious restraint effects on economic growth, and the cumulative shock response of total water consumption, industrial water consumption and agricultural water consumption to economic growth is positive. This shows that with the rapid economic growth, China's industrial and domestic water use has increased significantly. This is also in line with China's current economic development. Economic development has led to the continuous deepening of urbanization and industrialization, and industrial and domestic water use has increased. On the contrary, the cumulative shock response of agricultural water use to economic growth is negative; at present, China's agricultural planting is in an extensive production mode. Agricultural water is always the main water source, and the efficiency of water use is not high, resulting in a large amount of water being wasted. Thereby restricting economic development; as the economy continues to grow, mechanized farming is popularized on a large scale, and planting technology continues to improve, the use of water resources in agricultural production is gradually improving, resulting in the basic maintenance of agricultural water use or even a downward trend. China is a big agricultural country, and agricultural production is the foundation of the development of the national economy and the prerequisite for ensuring the stable development of China’s economy. Therefore, China should increase investment in water resources management, establish systematic water conservancy projects, and continuously improve water resources utilization technology; on the other hand, we must use economic means to limit the wasteful use of water resources, encourage everyone to save water, and alleviate industrial water use, and the growth rate of domestic water.

(2) According to the results of the variance decomposition, economic growth has an important influence on the forecast variance of water resources utilization, while only agricultural water use has a greater influence on the forecast variance of economic growth. In 2016, China's water resources use structure was 64.8% for agricultural water use, 21.6% for industrial water use, and 13.6% for domestic water use. It is necessary to further optimize the structure of water resources utilization, and coordinate the relationship between agricultural water, industrial water and domestic water, especially agricultural water and industrial water, which are the main water resources consumption in China. On the basis of ensuring the normal operation of economic life, save the use of water resources as much as possible, and ease the huge water pressure caused by natural scarcity and economic development. Through policy control and market economic measures, an effective water resources protection system and
feedback mechanism have been established to achieve long-term zero or even negative growth in water usage.

REFERENCES


