Analysis of the Impact of Water Conservancy Investment on High-quality Economic Development in Western China

Jiwei Zhu[1,2], Wenxing Fang[1,2,*], Xining Jing[1,2] and Jianmei Zhang[1,2]
[1]*State Key Laboratory of Eco-hydraulics in Northwest Arid Region, Xi'an University of Technology, Xi'an, China*
[2]*Research Center of Eco-hydraulics and Sustainable Development, The New Style Think Tank of Shaanxi Universities, Xi'an, China*

Keywords: Water conservancy investment, Economic development, Influence relationship, Influence path

Abstract: Water conservancy is the lifeblood of the national economy and is of great significance to the high-quality development of the region. In order to maximize the economic benefits of water conservancy investment (WCI), this article focuses on panel data from 2005 to 2018 in 12 provinces in western China, and constructs an economic development evaluation index system from five dimensions: innovative development, coordinated development, environmental development, opened development and shared development, and uses dynamic panel model to explore the influence relationship and path of western WCI on economic development. The results indicate that: there is a significant non-linear effect between WCI and economic growth, and show an inverted U-shaped relationship. This shows that with the expansion of WCI, economic growth has risen first and then declined. At present, the impact of WCI in the western region on high-quality economic development is in the promotion stage of positive and sustained growth. The results of this paper help to control the scale of water resources input and improve the effectiveness of water resources investment in the western region to support decision-making.

1 INTRODUCTION

Investment in water conservancy construction, as a controlling factor that promotes national economic growth, protects the lives of the people and the ecological environment, occupies a very important position in the economically backward western regions. After the 19th National Congress of the Communist Party of China, the central government's investment in water conservancy infrastructure has reached a new level. The western region has seized the opportunity to substantially increase the scale of investment in water conservancy infrastructure. On the one hand, it is to promote economy development and improve people's livelihood, on the other hand, it is also to solve the prominent contradiction between economic and social development and water supply and demand, and to achieve sustainable development of water resources and economic society (Qiu, 2020). Therefore, studying the impact of water resources investment on economic growth is of great significance for optimizing the structure of water conservancy construction investment and maximizing the economic benefits of water resources investment.

Many scholars have launched many discussions on the relationship between water resources investment and economic growth. Xu and Li (2012) measured the contribution of water conservancy construction investment to economic growth and found that water conservancy construction investment has the most direct impact on the primary industry. Ge and Yan (2015) used the general Solow production function to estimate that water conservancy construction investment has a 10% stimulating effect on GDP growth. Chen Yuanyuan (2019) analyzed the relationship between economic development and water conservancy construction investment in the western region from 2002 to 2016, and found that economic development has a significant long-term positive impact on investment in water resources construction. Wang et al. (2019) established a dynamic multiplier analysis model and concluded that the contribution rate of Guangdong's WCI to GDP from 2000 to 2017 was 0.65%-2.40%. Chen and Wang (2019) found that the investment in water conservancy construction has a long-term co-integration relationship with the total output value of agriculture, forestry, animal husbandry and fishery. In

Zhu, J., Fang, W., Jing, X. and Zhang, J.
Analysis of the Impact of Water Conservancy Investment on High-quality Economic Development in Western China.
In *Proceedings of the 7th International Conference on Water Resource and Environment (WRE 2021)*, pages 333-340
ISBN: 978-989-758-560-9; ISSN: 1755-1315

summary, the existing research mainly focused on analyzing the direct relationship between WCI and GDP, and lacks a comprehensive consideration of economic development, that is, analyzing its relationship with high-quality economic development. Therefore, based on panel data, this article uses a dynamic model to study the impact of WCI on high-quality economic development in the western region, and quantifies the contribution of WCI to economic and social development. This helps to understand the current situation of investment in water conservancy construction in the western region and promote high-quality economic and social development in the western region.

2 GENERAL SITUATION OF WCI AND ECONOMY IN THE WESTERN REGION

2.1 Data Sources

The data in this article are mainly derived from the 2005-2018 China Water Conservancy Yearbook, China Water Conservancy Statistical Yearbook, China Statistical Yearbook, National Economic and Social Development Statistical Bulletin, and statistical yearbooks of 12 provinces in the western region and their portal websites public information.

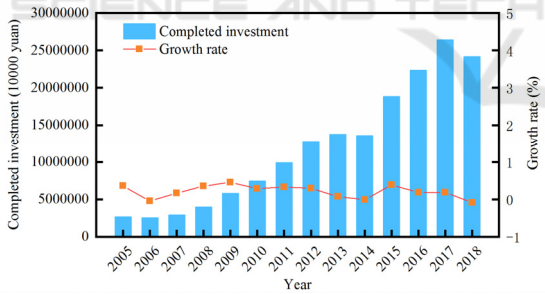

Figure 1: Completed amount and growth rate of WCI in the western region.

2.2 WCI in the Western Region

2.2.1 Analysis of WCI Scale

Water conservancy construction, as a key support area of national infrastructure construction, is one of the key investment directions of government financial funds (Wang, 2017). In terms of investment arrangements, the state pays attention to the central and western regions, especially the western regions. The details of the completion of the western WCI are shown in Figure 1.

2.2.2 Analysis of Sources of WCI

With the continuous expansion of WCI, the sources of WCI have gradually shown diversified characteristics. By categorizing the amount of WCI completed in 2005-2018 according to the source of funds, it is found that government investment has always occupied the main position, of which the central government has the largest proportion. Enterprise and private investment, and domestic loans, as new forces, also account for about one-seventh of each year. The use of foreign capital, others, and bonds account for a relatively small proportion, with an annual share of less than 10%. Figure 2 shows the proportion of different sources of funds in each year.

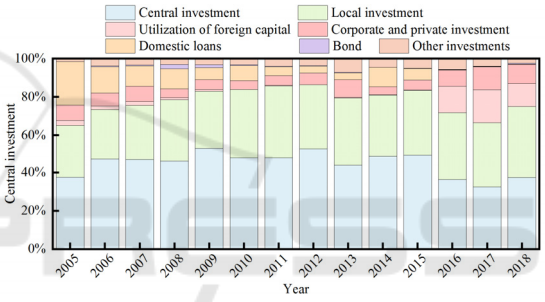

Figure 2: Distribution of WCI sources in the western region.

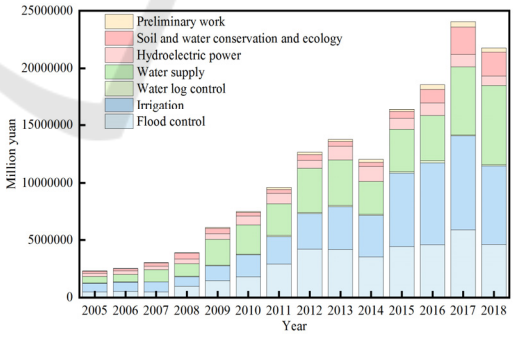

Figure 3: Distribution map of WCI by purpose in the western region.

2.2.3 Analysis of WCI Use

Based on the data of WCI completed in the western region from 2005 to 2018, it is divided into flood control engineering, water supply engineering, irrigation engineering, soil and water conservation and ecological engineering, water logging

engineering, hydropower engineering and preliminary work according to purpose. The specific situation is shown in Figure 3.

2.3 Economic Development in the Western Region

With the implementation of the western development strategy, new historical achievements have been made in the economic and social development of the western region, which has played an important supporting role in national development (Wang & Wang, 2019). The western region has entered a period of rapid development, and some provinces have been in the forefront of the country in economic indicators for many years. However, compared with the eastern region, the overall level of economic development in the western region is relatively backward, with its GDP accounting for only one-fifth of the country, and investment in fixed assets is relatively small.

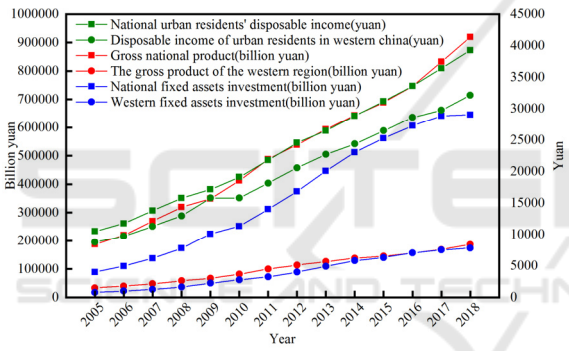

Figure 4: The economic development of the western region from 2005 to 2018

Although the disposable income of urban residents has been growing, there is still a large gap between the national average and the disposable income, as shown in Figure 4. Therefore, in the future, the western region should still be the main target of national policy support and investment tilt.

3 MODELS AND METHODS

3.1 Variable Selection

3.1.1 The Explained Variable

The explained variable is the level of economic development. This article quantifies the economic level of the western provinces from five dimensions: innovative development, coordinated development, green development, open development, and shared development, and establishes an indicator system (Pan & Luo, 2020), the results are shown in Table 1. It can be seen from the table that the indicator system consists of 5 first-level indicators, 12 second-level indicators, and 20 third-level indicators.

In order to eliminate the differences in dimension, order of magnitude, and orientation among the various indicators, this paper adopts the entropy method to standardize the selected indicator data. The forward index is processed by formula (1), and the reverse index is processed by formula (2).

$$u_{ij} = \frac{x_{ij} - x_{\min}}{x_{\max} - x_{\min}} \tag{1}$$

$$u_{ij} = \frac{x_{\max} - x_{ij}}{x_{\max} - x_{\min}} \tag{2}$$

Among them, x_{ij} represents the value in the i-th row and j-th column in the original data, x_{max} represents the maximum value in the j-th column in the original data, and x_{min} represents the minimum value in the j-th column in the original data. See (3), (4), (5) for specific calculation formulas, and it is stipulated that when $q_{ij} = 0, \lim q_{ij} \ln q_{ij} = 0$.

$$q_{ij} = \frac{u_{ij}}{\sum_{j=1}^{n} u_{ij}} \tag{3}$$

$$s_i = -\frac{1}{\ln n} \sum_{j=1}^{n} q_{ij} \ln q_{ij} \tag{4}$$

$$w_i = \frac{1 - s_i}{\sum_{i=1}^{m} (1 - s_i)} \tag{5}$$

Among them, q_{ij} represents the proportion of u_{ij} in the comprehensive sum of the data; s_i represents the index information entropy; w_i represents the index weight, the number of columns n=14, and the number of indicators m=20. Based on the entropy weighting method, the weights of each of the indicators are calculated to obtain the comprehensive economic development level of each province.

Table 1: Indicator system of economic development level.

Object level	Primary targets	Secondary indicators	Three-level indicators	Unit	Direction
Economic development	Innovation and Development	Innovation Input	Research and experimental development expenditures (Liu, 2020; Qiao, 2021)	billion yuan	+
			Full-time equivalent of research and experimental development personnel	Ten thousand people year	+
		Innovation Outputs	Number of domestic patent applications accepted (Li & Ju, 2021)	item	+
			Technical turnover (Cao, 2021)	billion yuan	+
	Coordinated Development	Industrial development coordination	Industry rationalization index (Peng & Zhu, 2020)	%	-
			Industrial Structure Advanced Index (Qiao, 2021; Peng & Zhu, 2020)	%	+
		Urban-rural economic harmonious	Consumption ratio of urban and rural residents (Cao, 2021; Peng & Zhu, 2020)	-	-
			Income ratio of urban and rural residents (Liu, 2020) (Peng & Zhu, 2020)	-	-
	Green Development	Green Life	Forest coverage (Ma & Chen, 2020; Wan et al., 2020)	%	+
			Harmless treatment rate of domestic garbage (Liu, 2020; Cao, 2021)	%	+
		Energy consumption	Total city natural gas supply (Liu, 2020)	billion cubic meters	-
		Environmental management	Urban green area (Liu, 2020; Peng & Zhu, 2020; Wan et al., 2020)	million hectares	+
	Open Development	Foreign trade	The proportion of total import and export in GDP (Liu, 2020; Duan et al., 2020)	%	+
		Utilize foreign capital	The proportion of foreign direct investment in GDP (Ran & Zheng, 2021)	%	+
		Tourism openness	International tourism receipts (Cao, 2021)	One hundred million dollars	+
	Shared Development	Economic shared development	per capita GDP (Liu, 2020; Duan et al., 2020; Ma & Chen, 2020; Wan et al., 2020)	yuan/people	+
			Urbanization rate (Peng & Zhu, 2020)	%	+
		Social shared development	Staff in health institutions (Cao, 2021)	million people	+
			Education funding (Liu, 2020)	million yuan	+
			Volume of passenger traffic (Liu, 2020)	million people	+

3.1.2 Core Explanatory Variables

The core explanatory variables are the WCI and the square item of WCI in 12 provinces, municipalities, and autonomous regions in the western region.

3.1.3 Control Variables

In order to better describe the explained variables, this article selects human capital, government intervention, urbanization rate, and degree of opening to the outside world as the control variables of this model. The main variables involved in this article

include: economic development (Eco), WCI (Water), WCI square item (Waterq); intermediary variables include: industrial structure (Ind), technological progress (Rd) and resource allocation (Diskl); control Variables include: human capital (Hum), urbanization level (Urb), government intervention (Gov), and degree of openness (Imp). To ensure the stability of the data, the logarithmic value of the WCI and the degree of openness are taken, and the square term of the WCI is obtained by taking the logarithmic value of the WCI and then square (Sun & Zhou, 2019).

3.2 Model Construction

Based on the endogenous economic growth model, combined with the economic development indicator system, this paper studies the impact of WCI on economic development and establishes a basic model, as shown in formula (6).

$$\mathrm{Eco}_{it} = \beta_0 + \beta_1 W_{it} + \beta_2 X_{it} + u_i + \varepsilon_{it} \quad (6)$$

Among them, Eco_{it} represents the level of economic development of place i in period t, W_{it} is the amount of WCI completed in place i in period t, X_{it} is other factors that affect economic development in the same period and the same place, u_i is the individual disturbance term, and ε_{it} is random disturbance items.

β_0 is the intercept term of the model, β_1 is the variable coefficient of WCI, the positive and negative coefficients represent the direction of the influence of WCI on economic development, and the magnitude indicates the degree of influence. To improve the accuracy and scientific character of the model, this article optimizes the above basic model as follows:

3.2.1 Dynamic Panel Model

In order to assess whether there is a difference in the impact of WCI on economic development under different investment scales, this paper introduces the square term of WCI. Economic development is a process of dynamic changes in the economic structure. The impact of the previous level on the current development cannot be ignored. In order to better explore the impact of water investment on economic development, a dynamic Panel model is constructed by introducing third-order lagged variables of the explanatory variables. The optimized model is shown in (7).

$$\mathrm{Eco}_{it} = \beta_0 + \beta_1 \mathrm{Eco}_{it-1} + \beta_2 Eco_{it-2} + \beta_3 Eco_{it-3} + \beta_4 W_{it} + \beta_5 W_{q_{it}} + \beta_6 X_{it} + u_i + \varepsilon_{it} \quad (7)$$

In the formula, Eco_{it-1}, Eco_{it-2}, Eco_{it-3}, respectively represent the first, second, and third-order lagging terms of the economic development level, and $\mathrm{W\_q}_{it}$ is the square term of WCI, and the meaning of other variables is the same as equation (6).

3.2.2 Model Robustness Test

The robustness of the model has an important impact on the accuracy of the measurement results, and index replacement is a common method to test the robustness of the model. The development level of the tertiary industry is one of the important indicators that reflect the level of productivity development of a country or region (Zhao, 2013). This article uses the added value of the tertiary industry as a test index for the replacement economic development level.

4 RESULTS AND ANALYSIS

4.1 Analysis of Benchmark Results

Considering that the relationship between the explained variable and the core explanatory variable may be mutual: WCI will promote economic development, and economic development will in turn affect the scale of WCI, so the model may be endogenous. The results of LR test and Wald test both concluded that there is heteroscedasticity between the model disturbance items. In order to improve the accuracy of the regression results, the system GMM method is used to regress the model after the second-order difference of the variables.

The test results of AR (1) and AR (2) in Table 2 show that the model has first-order autocorrelation, but no second-order autocorrelation and no autocorrelation of the disturbance terms. Meanwhile, the p-values of the Sargan test are both greater than 0.1, indicating that the instrumental variables are effectively chosen. Therefore, it is feasible to use the systematic GMM method to estimate the model.

It can be seen from the results that the regression coefficients of the economic development of the three lagging periods are all very significant, indicating that the economic development of the western region will be affected by the previous development level. Further observation of the regression coefficient of WCI, we found that regardless of the introduction of control variables, the regression coefficient of WCI on economic development are all positive,

respectively 0.3276*, 0.2949**, 0.2028*, 0.2535* and 0.3297***, and the P values are all within their respective ranges, so they have also passed the significance test. The significance test shows that in the transitional stage of economic growth in the west of our country, strengthening WCI to promote economic development is a viable path choice. For the square term of WCI in Table 2, the coefficients are all significantly negative, which shows that with the increase of WCI, the economy shows a trend of first increase and then decrease, that is, there is an inverted U-shaped relationship between WCI and economic development. It shows that the role of WCI in promoting economic growth is conditionally limited, and a reasonable investment scale is the key to giving full play to the economic benefits of WCI. Once it exceeds the best advantage, it will hinder economic growth.

Table 2: Analysis of the impact of WCI on economic development.

	(1)	(2)	(3)	(4)	(5)	Robustness test
Eco(-1)	-0.6685***	-0.6551***	-0.5778***	-0.5808***	-0.6119***	-0.4524***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Eco(-2)	-0.2502**	-0.2468**	-0.2872***	-0.2710**	-0.2794**	-0.2285***
	(0.013)	(0.004)	(0.001)	(0.001)	(0.009)	(0.000)
Eco(-3)	-0.2686***	-0.2745**	-0.2524*	-0.2279*	-0.1943*	-0.1448
	(0.001)	(0.001)	(0.016)	(0.015)	(0.033)	(0.053)
Water	0.3276*	0.2949**	0.2028*	0.2535*	0.3297***	0.3615***
	(0.012)	(0.008)	(0.018)	(0.013)	(0.001)	(0.000)
Waterq	-0.0117*	-0.0106*	-0.0073*	-0.0090*	-0.0119***	-0.0129***
	(0.015)	(0.011)	(0.024)	(0.015)	(0.001)	(0.000)
Urb		1.1795*	1.2354*	1.1501*	-3.6883	1.5548*
		(0.021)	(0.017)	(0.036)	(0.847)	(0.042)
Imp			0.0159***	0.0159***	0.0363	0.0060*
			(0.000)	(0.000)	(0.700)	(0.022)
Gov				0.0315	1.0521	0.2879*
				(0.729)	(0.052)	(0.017)
Hum					0.0165***	-45.5774*
					(0.001)	(0.027)
_cons	0.0136***	0.01318838***	0.0116***	0.0119***	0.0121***	-0.0079*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)
AR(1)	-3.0243	-2.9216	-2.9193	-2.8952	-2.9031	-2.5414
	(0.0025)	(0.0035)	(0.0035)	(0.0038)	(0.0037)	(0.0110)
AR(2)	-0.0652	0.3596	0.5131	0.5373	0.7738	1.2505
	(0.9480)	(0.7191)	(0.6079)	(0.5911)	(0.4390)	(0.2111)
Sargan test	84.47629	102.6454	107.5081	115.7045	132.7714	136.2922
	(0.6722)	(0.7886)	(0.9489)	(0.9483)	(0.8405)	(0.7817)

*Note: * p<0.05, ** p<0.01, *** p<0.001; The P value of the corresponding statistic is in parenthes*

However, judging from the WCI coefficient, the western region is still far from the best point at this stage, and it is still at a stage where it is necessary to continue to increase investment. The rapid development of the western region still requires government investment and policy support. As far as the control variables are concerned, the regression coefficients of human capital, degree of development, and urbanization are all significantly positive, indicating that higher levels of human capital, degree of openness, and urbanization rate are all conducive to economic development. Although the coefficient of government intervention on economic development is positive, However, the reliability is not high due to its low significance.

4.2 Robustness Analysis

Re-regression the value added of the tertiary industry as the explained variable, and the results are shown in Table 2. The significance and direction of the regression coefficients did not change substantially, but only the magnitude of the coefficients changed. The estimated results still support the conclusion that WCI can effectively improve economic development and the relationship between the two is inverted U-shaped, indicating the regression of the model The result is robust.

5 SUMMARY AND CONCLUSION

Using descriptive data statistics, analyzing from the three aspects of GDP, investment in fixed assets, and people's living standards, it is concluded that the social and economic development of the western region is in a state of continuous growth, but there is a certain gap compared with the eastern region. Some indicators have not reached the national average. Analyzing the current situation and evolution trend of WCI in the western region from three perspectives of investment scale, investment source and investment purpose, it can be found that the total amount of water investment in the western region has been increasing in the past 14 years. Mainly for irrigation projects, soil and water conservation, ecology, and preliminary work have gradually become the focus of investment. The results show that there is a significant non-linear effect between WCI and economic growth, showing an inverted U-shaped relationship, that is, as the scale of WCI expands, economic growth shows a trend of rising first and then falling. It shows that the expansion of WCI scale before reaching the optimal scale has a positive impact on economic growth, and exceeding the optimal investment scale will hinder economic development.

The scale of WCI should match the local economic development, population size, and natural conditions. We should not blindly pursue scale expansion. It is necessary to reasonably control the scale of investment according to specific needs. At this stage, the western region is still at a stage where it is necessary to continue to increase investment in water conservancy, and we must continue to pay attention to investment in weak links in water conservancy infrastructure construction. Pay attention to the gradual transformation of WCI from traditional power generation and irrigation to water conservation and ecological and water conservancy informatization construction, and continue to accelerate the pace of water conservancy modernization.

ACKNOWLEDGMENTS

This research was funded by Project of National Natural Science Foundation of China (71774132), Shaanxi Water Conservancy Science and Technology Project (2020SLKJ-22), Shaanxi Provincial Department of Education Key Scientific Research Project (20JT053).

REFERENCES

Cao, X. C. (2021). Research on Evaluation of High-quality Economic Development of Heilongjiang Province Based on Entropy Method. *Business Economics*, *3*, 27-28+75.

Chen, L., & Wang, Q. (2019). Research on the relationship between China's water conservancy facility investment and agricultural economic growth. *Development Research*, *5*, 39-46.

Chen, Y. Y. (2019). *Research on the relationship between economic development and investment in water conservancy construction in the western region*. Xi'an: Xi'an University of Technology.

Duan, X., Ren, Q. L., & Li, M. R. (2020). Social capital, industrial structure optimization and high-quality economic development——Based on the empirical test of provinces along the Silk Road Economic Belt in China. *Journal of Lanzhou University of Finance and Economics*, *36*(05), 1-20.

Ge, J. Y., & Yan, G. J. (2015). Mathematical model of the contribution of water conservancy investment to national economic growth. *Water Conservancy Economics*, *1*, 36-37.

Li, J. W., & Ju, Z, J. (2021). Research on the Evaluation of the Quality of Marine Economic Development in

Guangdong Province. *Journal of Henan University of Technology (Social Sciences Edition)*, *37*(01), 14-21

Liu, Z. X. (2020). Evaluation of China's economic development quality based on new development concepts. *Times Finance*, *29*, 1-3+12.

Ma, G. Q., & Chen, F. (2020). Study on the evaluation of regional economic development quality of prefecture-level cities in Shandong Province. J*ournal of Qingdao University (Natural Science Edition)*, *33*(04), 110-114.

Pan, Y. R., & Luo, L. W. (2020). The impact of infrastructure investment on high-quality economic development: a study on mechanism of action and heterogeneity. *Reform*, *6*, 100-113.

Peng, D. Y., & Zhu, M. T. (2020). Priority analysis and measurement of factors affecting high-quality economic development. *Ecological Economy*, *36*(12), 50-56+76.

Qiao, M. H. (2021). Environmental Regulation, Spatial Spillover and High-quality Economic Development: An Empirical Study Based on the Dubin Model of Provincial Panel Space in China. *Ecological Economy*, *37*(04), 147-155.

Qiu, H. W. (2020). Research on the Measurement Method of Shaanxi Water Conservancy Infrastructure Investment Scale Considering the Congestion Effect. *Shaanxi Water Resources*, *2*, 192-193+196.

Ran, Z., & Zheng, J. H. (2021). Innovative Ability and High-quality Development of Regional Economy-An Analysis Based on the Perspective of Technological Differences. *Shanghai Economic Research*, *4*, 84-99.

Sun, X. X., & Zhou, X. L. (2019). Transportation infrastructure investment, factor market distortion and economic growth. *Transportation System Engineering and Information*, *19*(01), 13-18.

Wan, Y. Y., Su, H. Y., and Liu, J. (2020). Regional coordination evaluation of ecological civilization construction and high-quality economic development. *Statistics and Decision*, *36*(22), 66-70.

Wang, Y., Ni, P. T., & Wei, J. B. (2019). Research on the contribution rate of water conservancy investment to the economy in Guangdong Province. *Guangdong Water Resources and Hydropower*, *4*, 76-78+83.

Wang, Y. (2017). *Research on Rural Water Conservancy Investment in Hanjiang District, Yangzhou City*. China: Yangzhou University.

Wang, Y. B., & Wang, Y. Y. (2019). Taking multiple measures simultaneously to promote high-quality industrial development in the western region. *People's Forum*, *35*, 90-91.

Xu, B., & Li, W. (2012). Analysis of the promotion effect of water conservancy investment on economic growth. *Water Conservancy Development Research*, *12*(03), 11-15+31.

Zhao, D. (2013). *Research on the optimization of the internal structure of the tertiary industry in my country*. Dalian: Dalian Maritime University.