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Economic impact of investment in water conservancy construction in Hubei Province

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ABSTRACT

Water conservancy construction constitutes a part of regional economic and social development, which plays an important role in promoting economic development and driving domestic demands in Hubei Province. The development of water conservancy construction can promote regional economic growth and restrict regional economic development to some extent. Therefore, it is of great practical significance to study the driving effects of water conservancy construction on regional economic growth in Hubei Province and determine the investment direction of water conservancy construction. Based on the Sustainable Development Theory, this paper takes the water conservancy investment in Hubei Province as the main research object, combines with the current situation and characteristics of Hubei Province and discusses the influence of water conservancy investment on the regional economy and the existing problems in depth. Based on the relevant data of water conservancy in Hubei Province from 2005 to 2018, a model is established in the paper and empirical analysis of the correlation between water conservancy investment and the gross regional product is conducted by using econometrics methods such as Granger causality test, co-integration test, and correlation analysis. Finally, corresponding policy suggestions are proposed based on the above analysis results.

Keywords: Water conservancy investment; Economy; Granger causality test; Hubei Province

1. Introduction

Water is an indispensable natural and environmental resource for human production and life. Water conservancy is the foundation of economic and social development and the lifeblood of national economic development. As an important part of basic water conservancy industry, the water conservancy economy relies on and is inseparable from the national economy [1,2]. In general, water conservancy investment in Hubei Province can not only promote the development of other industries and drive domestic demand but also play its own long-term role in constantly improving water conservancy infrastructure construction, further improving people's living environment, making economy and society develop sustainably and realizing sustainable development of water conservancy investment in Hubei Province. Although the investment scale of water conservancy construction in Hubei Province has increased substantially since the 11th 5 Year Plan, major breakthroughs have been made by a number of key water conservancy projects in people's life and social and economic development [3,4]. However, there is still a certain gap existing between the present situation of water conservancy investment and economic development in Hubei Province.

At present, the major task of economic development in Hubei Province is to stimulate domestic demand to promote sustained and rapid economic growth. Therefore, it is of great significance to study the relationship between water conservancy construction investment and economic growth [5]. In terms of water conservancy industry, water conservancy construction can not only bring economic effects but also great social effects and environmental

benefits. Objective analysis of the relationship between water conservancy investment and economic growth in Hubei Province can not only provide a basis for the water conservancy industry to formulate development strategies, but also provide references for the government to formulate macroeconomic policies. Against the backdrop of responding to the current financial crisis, the government can determine a reasonable scale of government investment and optimize the structure of government investment, and meanwhile improve the efficiency of the use of financial funds and deepen the reform of the financial system.

A study argued that the effective management of water resources had become the focus of debate. Owing to the scarcity and increasing importance of water resources, they analyzed how to improve the organizational efficiency of water supply companies with different scale of investment and different clusters of water supply facilities among structures of different ownerships [6]. Based on the prior-test logarithm cost function, studied the relationship between the public infrastructure investment and economic productivity over 35 y in Greek [7]. The research showed that infrastructure investment played an important role in reducing agricultural production cost and greatly improving agricultural productivity. Numerically, for everyone percentage point increase in infrastructure investment, the total cost of agricultural production will be cut by 0.38%. Has discussed how to optimize water conservancy investment and establish a reasonable investment scale [8]. Research constructed a stochastic dynamic programming model and studied urban water investment planning in Australia and progress achieved [9]. And studied the optimization of investment scale and efficiency of water conservancy construction [8]. The previous study analyzed the cost and benefit of water resources investment and found that water resources supply and protection investment have a great role in promoting social development [10].

A measured the impact of water conservancy investment on the output efficiency of cultivated land by establishing a Translog stochastic frontier function model. It was concluded that the investment in agricultural water conservancy infrastructure played a positive role in improving the technical efficiency of farmland utilization [11,12]. Also focused on the impact of water conservancy investment on agricultural economic growth and believed that water conservancy investment had a significant positive lag effect on agricultural economic growth [13,14]. Have found that the rapid growth in fixed-asset investment had a significant effect on economic growth, and the more investment was made, the faster the growth was [15,16]. Analyzed the relationship between infrastructure investment and economic growth in Shaanxi province by establishing relevant measurement models, and found that only increasing investment in infrastructure can promote sustained economic growth in the process of marketization [17]. Based on the empirical analysis of the lag effect of water conservancy investment in Shaanxi province, also pointed out that it was attributed to the large investment amount in agricultural water conservancy, long construction period, and long investment return period coupled with the complicated fund approval process and the project feasibility analysis, consequently the investment benefit of agricultural water conservancy infrastructure generally started to emerge three years after the fund was put into operation [18,19]. Based on Malmquist-FGLSS two-stage model, analyzed the effect of government intervention on the investment performance of farmland water resources in the main grain-producing areas. It was found that government intervention, farmers' per capita net income and the scale of water projects all had an impact on investment efficiency [20,21]. Water investment efficiency was negatively correlated with the change of the financial management system and was positively correlated with farmers' per capita net income. The unreasonable scale of water conservancy projects will lead to low investment efficiency.

Scholars at home and abroad have explored fruitfully on the economic effect of public infrastructure investment and obtained successful results with important theoretical and methodological enlightenments and references to our research. However, there are some shortcomings in the existing research: firstly, since the research on water conservancy investment features mostly the overall analysis, there is less analysis of the particularity of local investment. As far as China is concerned, the central government increases the investment in water conservancy and this requires the local governments to actively implement it. Therefore, it is of great significance to study the local water conservancy investment. Secondly, most of the research on water conservancy investment is qualitative analysis, especially the problem of the insufficient scale of water conservancy investment is mostly described qualitatively from the current situation of water conservancy development, while few of the quantitative analysis is carried out on the insufficient scale of investment, especially the analysis on the level of investment scale of local governments suffers severe shortage. In view of this basis, this paper tries to further study the related issues concerning water conservancy investment from the above aspects.

2. Current situation of water conservancy investment in Hubei Province

Since the founding of People's Republic of China, especially since the reform and opening up, water conservancy industry in Hubei Province has made remarkable achievements. Big rivers have been brought under the effective control and notable progress has been made in building water conservancy projects to improve people's well-being. Meanwhile, the construction of water ecological civilization has been accelerated and the capacity of the water conservancy industry has been developing. Hubei Province, supported by a series of policies and measures to increase water conservancy investment by the central government, has witnessed steady growth in the scale of water conservancy investment, continuously expanded sources of investment and continuously optimized investment structure. During the 12th Five-Year Plan period,, the total investment in water conservancy in Hubei Province reached 107.06 billion yuan, with an average annual investment of 21 billion yuan.

Since the investment in water conservancy construction industry features a higher degree of economies of scale and long construction cycle, the water conservancy investment,

therefore, is the most typical representative. When a water conservancy infrastructure supply shortage occurs, a competitive investment can quickly meet the needs of society. However, it takes a long time for water conservancy investment to be able to meet social needs. Hence, in a certain period, investment scale exceeding total social demand and with a relatively long interval can be chosen for basic projects in Hubei Province. In this way, the relative output surplus of product oversupply will occur in a period of time after the completion of the investment. The output of the water conservancy sector is an indispensable part of the production and living consumption of the general public and all the other sectors of society. Therefore, if the market is allowed to regulate itself, even if the supply of these products and the corresponding selling prices change slightly, it will lead to changes in the national economy and exert extremely serious negative effects on the social economy.

In 2018, the annual investment of water conservancy in Hubei Province reached 373.52 billion yuan, up 37.6% over the previous year (as shown in Table 1). The growth rate of water conservancy investment fluctuated widely. In 2012, the investment of water conservancy exceeded 100 billion yuan for the first time, and subsequently increased year by year. Since 2013, the overall growth rate has shown an upward trend. As an important foundation of the social economy, water conservancy should meet the requirements of sustainable development and proper advance. In recent years, the investment in water conservancy projects made by the Hubei provincial government has increased rapidly. However, in the comparison of the data of government water conservancy investment from 2006 to 2010, it was found that the growth rate decreased from 41% to 28% from 2007 to 2008, and even further decreased to 23% in 2010. The results of the above indicators show that the investment of the Hubei provincial government in water conservancy is very unstable.

3. An empirical study on water conservancy investment and economic development in Hubei Province

3.1. Stationarity analysis of time series

In the stationarity test of time series by using the correlation method, it is assumed that the time series is non-stationary. Due to the relationship between factors and variables, special attention is paid to the analysis of the time series in order to see whether it is stationary or whether the fluctuation range is small. Therefore, before conducting a correlation analysis, we must firstly verify whether the variables are stationary. The unit root test is the most commonly used method of time series tests. We use the augmented Dickey–Fuller (ADF) test to complete the unit root test, so as to judge whether the time series is stationary.

$$y_t = a_0 + a_1 t + \gamma y_{t-1} + \sum_{j=1}^{p} \Delta y_{t-j} + v_t \quad (1)$$

If the test results show that A_3 is significantly 0, it indicates that the variable is non-stationary with unit root. Otherwise, if A_3 is significantly different from 0, it indicates that the variable is a stationary process with no unit root.

It can be seen from Table 2 that the *t*-value of water conservancy investment is 5.753660, which is higher than the critical value at each significant level, so the null hypothesis is accepted and the water conservancy investment is non-stationary.

It can be seen from Table 3 that the *t*-value of water conservancy investment amount is 0.372920, which is higher

Table 1
Fixed investment and water conservancy investment in Hubei Province

Time	Fixed assets investment in the whole society (100 million yuan)	Fixed assets investment in the whole society by industry of water conservancy facilities management (100 million yuan)	Percentage of water conservancy investment in the whole society (%)
2005	1,809.45	114.07	6.30
2006	2,264.81	141.88	6.26
2007	2,676.58	200.6	7.49
2008	3,343.47	258.35	7.73
2009	4,330.36	408.45	9.43
2010	5,647.01	505.77	8.96
2011	7,866.89	780.7	9.92
2012	10,262.7	1,084.2	10.56
2013	12,557.34	1,124.1	8.95
2014	15,578.3	1,231.38	7.90
2015	19,307.33	1,593.9	8.26
2016	22,915.3	1,894.25	8.27
2017	26,563.9	2,714.69	10.22
2018	30,011.65	3,735.2	12.45

Since 2011, the data release standard for urban fixed asset investment has been changed to fixed asset investment (excluding rural households), which is equal to the original standard for urban fixed asset investment plus project investment by rural enterprises and institutions.
Data source: National Bureau of Statistics

Table 2
Unit root test of water conservancy investment amount in Hubei Province

Exogenous: Constant			
Lag length: 0 (Automatic – based on SIC, maxlag = 2)			
		t-Statistic	Prob.*
ADF test statistic		5.753659691200026	0.99999970754485
Test critical values:	1% level	–4.057909684396629	
	5% level	–3.119909565124083	
	10% level	–2.701103254904266	

* indicate that the statistical values are significant at the confidence levels of 10%.

Table 3
First-order difference stationarity test of water conservancy investment amount in Hubei Province

Exogenous: Constant			
Lag length: 0 (Automatic – based on SIC, maxlag = 2)			
		t-Statistic	Prob.*
ADF test statistic		0.3729197690732236	0.9715902729418478
Test critical values:	1% level	–4.121989944705691	
	5% level	–3.144919702357464	
	10% level	–2.713750903328943	

* indicate that the statistical values are significant at the confidence levels of 10%.

Table 4
Second-order difference stationarity test of water conservancy investment amount in Hubei Province

Exogenous: Constant			
Lag Length: 0 (Automatic – based on SIC, maxlag = 2)			
		t-Statistic	Prob.*
ADF test statistic		–3.192236914485774	0.04869663075715661
Test critical values:	1% level	–4.200055631013585	
	5% level	–3.175351906549292	
	10% level	–2.728985020298166	

* indicate that the statistical values are significant at the confidence levels of 10%.

than the critical value at each significant level. Therefore, the null hypothesis is accepted, and the first-order difference of water conservancy investment is non-stationary.

It can be seen from Table 4 that the *t*-value of the second-order difference of water conservancy investment is –3.192237, which is the critical value at the significance level less than 5% and greater than the critical value –4.200056 at 1% significance level. Therefore, the null hypothesis is rejected at 5% significance level and the second-order difference of water conservancy investment is stationary

It can be seen from Table 5 that the *t*-value of the gross regional product (GDP) of Hubei Province is 3.133877, which is higher than the critical value at each significant level. Therefore, the null hypothesis is accepted and the regional GDP is non-stationary.

It can be seen from Table 6 that the *t*-value of GDP is –1.538246, which is higher than the critical value at each significant level. Therefore, the null hypothesis is accepted and the first-order difference of regional GDP is non-stationary.

It can be seen from Table 7 that the *t*-value of the logarithm of GDP is –3.337009, which is the critical value at the significance level less than 5% and greater than critical value –4.200056 at 1% significance level. Therefore, the second-order difference of GDP is stationary when the null hypothesis is rejected at 5% significance level.

It can be seen from the above tables, at 5% significance level, the *P*-value of the unit root of the water conservancy investment and the regional GDP in Hubei Province, together with the corresponding *P*-value of the ADF test value of the first-order difference test of are all greater than 0.05, which suggests that the null hypotheses are accepted, namely that the unit root and the first-order difference of the water conservancy investment and regional GDP are all non-stationary. However, in terms of their second-order difference, the *p*-value of the ADF test of the sequence after the difference is less than 0.05, which shows that there is a significant difference between δ-value and 0, indicating the null hypothesis is rejected. It shows that the sequence after the second-order

Table 5
Unit root test of GDP in Hubei Province

Exogenous: Constant			
Lag length: 0 (Automatic – based on SIC, maxlag = 2)			
		t-Statistic	Prob.*
ADF test statistic		3.133876834809242	0.9999597026775209
Test critical values:	1% level	–4.057909684396629	
	5% level	–3.119909565124083	
	10% level	–2.701103254904266	

* indicate that the statistical values are significant at the confidence levels of 10%.

Table 6
First-order difference stationarity test of GDP in Hubei Province

Exogenous: Constant			
Lag length: 0 (Automatic – based on SIC, maxlag = 2)			
		t-Statistic	Prob.*
ADF test statistic		–1.538245716778314	0.4811182222213769
Test critical values:	1% level	–4.121989944705691	
	5% level	–3.144919702357464	
	10% level	–2.713750903328943	

* indicate that the statistical values are significant at the confidence levels of 10%.

Table 7
Second-order difference stationarity test of GDP in Hubei Province

Exogenous: Constant			
Lag Length: 0 (Automatic – based on SIC, maxlag = 2)			
		t-Statistic	Prob.*
ADF test statistic		–3.337008839530907	0.03879232583911609
Test critical values:	1% level	–4.200055631013585	
	5% level	–3.175351906549292	
	10% level	–2.728985020298166	

* indicate that the statistical values are significant at the confidence levels of 10%.

difference is stationary, that is, the water conservancy investment and GDP are all integrated of order two.

3.2. Co-integration test of water conservancy investment and GDP

The two-time series are non-stationary, but there may still be a (long-term) stationary or equilibrium relationship between the two variables. If so, the time series is said to be cointegrated. The following will be the co-integration test analysis between the water conservancy investment and GDP in Hubei Province. The model is established as follows:

$$Y_t = a_0 + a_1 x_t + \mu_t \quad (2)$$

In this paper, Johansen's co-integration test is adopted to analyze the co-integration relationship between water conservancy investment and GDP. The test results obtained by Eviews8.0 analysis are as follows:

It can be seen from Table 8 that the Johansen's co-integration test rejects the assumption that the number of co-integration equations is 0 at the 5% confidence level and the probability of 0.0226, and accepts the assumption that the number of co-integration equations is 1 at the probability of 0.5115, indicating that there is a long-term equilibrium relationship between water conservancy investment and regional GDP.

3.3. Sequence correlation test of water conservancy investment and GDP

Eviews8.0 is adopted in this paper to conduct correlation test and analysis on the relationship between water conservancy investment and GDP from 2005 to 2018, the model is set as follows:

$$y_t = a_{10} + \sum_{j=1}^{r} a_{1j} y_{t-j} + \varepsilon_{1t} \quad (3)$$

Table 8
Test results of the co-integration relationship between water conservancy investment and GDP

Unrestricted cointegration rank test (Trace)				
Hypothesized		Trace	0.05	
No. of CE (s)	Eigenvalue	Statistic	Critical value	Prob.**
None*	0.763599	17.73741	15.49471	0.0226
At most 1	0.035255	0.430702	3.841466	0.5116

Trace test indicates 1 cointegrating Eqn(s) at the 0.05 level.
*denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon–Haug–Michelis (1999) *p*-values.

Table 9
Correlation test results of water conservancy investment and GDP

Dependent variable: LOG(Y)				
Method: Least squares				
Date: 01/12/19 Time: 11:54				
Sample: 2005–2018				
Included observations: 14				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	5.691891	0.151494	37.57179	0.0000
LOG(X)	0.585982	0.022847	25.64790	0.0000
R-squared	0.982085	Mean dependent var		9.527051
Adjusted *R*-squared	0.980592	S.D. dependent var		0.652816
S.E. of regression	0.090946	Akaike info criterion		–1.825530
Sum squared resid	0.099255	Schwarz criterion		–1.734236
Log likelihood	14.77871	Hannan–Quinn criter.		–1.833981
F-statistic	657.8148	Durbin–Watson stat		0.951290
Prob(*F*-statistic)	0.000000			

$$y_t = a_{20} + \sum_{j=1}^{p} a_{2j} y_{t-j} + \sum_{k=1}^{p} b_{2k} x_{t-k} + \varepsilon_{2t} \quad (4)$$

In the formula, X is the investment amount of water conservancy, Y is the GDP, and t is the time series from 2005 to 2018.

Table 9 shows that the DW statistic value of this regression equation is 0.95. At the significance level of 5%, the lowest critical value of DW distribution with a sample size of 14 is 1.045. Since 0.95 is less than 1.045, it indicates that there is a positive autocorrelation, that is, there is a positive correlation between water conservancy investment and GDP.

3.4. Causal analysis of water conservancy investment and GDP

Based on the previous co-integration tests, we have known that there is a long-term stationary relationship between variables, but whether there is a causal relationship between variables still needs to be verified. The causality between water conservancy investment and GDP is calculated by Eviews8.0, and the Granger test results are shown in the following table:

It can be concluded from Table 10 that when the lag order is 2, at the significance level of 5%, that GDP is not the Granger reason of water conservancy investment rejects the null hypothesis, while that water conservancy investment is not the Granger reason of GDP accepts the null hypothesis. That is to say, there is no two-way causal relationship between water conservancy investment and GDP. GDP is the Granger reason of water conservancy investment, while water conservancy investment is not the Granger reason for GDP. The results show that the water conservancy investment has a long-term growth effect on the national economic growth, which strongly promotes the development of the national economy, while the regional GDP has no driving effect on the water conservancy investment. However, due to some practical factors, such as the water conservancy industry does need the support of government funds, and the development of a technical level of water conservancy industry, we cannot claim that the regional GDP has no driving effect on water conservancy investment. The effect is just not that obvious and cannot be reflected in the data very well. Hence, this requires some relevant policies to promote the development of water conservancy construction.

4. Policy proposals on increasing investment in water conservancy to promote economic growth in Hubei Province

4.1. Strengthen local financial support for water conservancy investment

In view of the low scale and unstable growth of local government investment in water conservancy, it is necessary to establish a mechanism to increase water conservancy

Table 10
Granger causality test results of water conservancy investment and GDP

Null hypothesis:	Obs	*F*-Statistic	Prob.
Y does not Granger Cause *X*	10	12.69844953929541	0.01097366774952668
X does not Granger Cause *Y*		1.470328546826135	0.3146182461930083

investment and social investment simultaneously. Local governments should increase financial support for water conservancy investment according to the continuous improvement of local economic development level and increasing fiscal revenue in the future, so as to ensure the long-term, sustained, and stable growth of water conservancy investment. Specifically, local governments can determine in advance the corresponding proportion of water conservancy investment in the whole society according to the needs of social and economic development, so as to ensure the need of water conservancy investment for construction funds.

4.2. Reasonably define the scope and scale of government investment

An accurate distinction should be among competitive projects, basic projects, and public welfare projects in government investment. Government investment should be focused mainly on non-profit areas that promote economic development where private capital is unwilling or unable to enter, which mainly refers to the basic projects and public welfare projects. To reduce the participation of government capital in competitive fields, local governments can guide social capital into some monopolistic industries that are not related to national security, and remove unreasonable restrictions on private investment in these industries, so as to promote the increase of output rate of social investment. At the same time, local governments need to appropriately determine the scale of government investment in line with the needs of economic and social development, avoiding underinvestment or overinvestment.

4.3. Encourage private capital to participate in the construction of water conservancy construction

Local governments should absorb the domestic experience and gradually explore policies and measures for private capital to participate in investment and the reform of diversified water conservancy investment and financing system. Local governments should try their best to create opportunities and conditions for private investment in water conservancy projects. Local governments can also combine the market operation methods such as real estate development and tourism development with the investment and construction of water conservancy, and put the operating income into those water conservancy projects that can improve the regional environment and enhance the value of regional land. Platforms for water conservancy investment and financing of local government can be established to attract more private capital and financial capital to participate in water conservancy construction.

5. Conclusion

Through the co-integration tests, it is found that there is a long-term stationary relationship between water conservancy investment and regional GDP in Hubei Province. At present, the investment in water conservancy construction of Hubei Province accounts for only a relatively small share in the fixed assets. However, it plays a certain role in the growth of the national economy. Therefore, it is necessary to increase investment in water conservancy construction in Hubei Province, which can not only promote further economic development in Hubei Province but also further meet people's life demand. Due to the long cycle of the construction of water conservancy facilities, it takes a long time from investment initiating operation to project completion. Although the role of investment in water conservancy construction on economic growth is not obvious at the very beginning, its role will continuously increase after its completion. Furthermore, the management and supervision of water conservancy projects under construction should be strengthened on the basis of investment completion so as to extend the service life of water conservancy projects.

With the increase of water conservancy investment, the contribution to the employment of Hubei Province increases first and then decreases. It can be seen that water conservancy investment also helps the employment to some extent and correspondingly increases the employment opportunities. The employment first increases and then gradually decreases. This may be because, with the progress of modern technology and the use of high technology, the driving force of water conservancy construction projects to employment has decreased to some extent.

Since water conservancy investment often has obvious social benefits and low economic benefits, local governments need to invest lasting and substantial costs to generate corresponding benefits, and such costs will generate greater economic benefits if they are invested in other projects. Local governments who are concerned about economic growth will think that investing in other projects is more beneficial to the economic development of the region than investing in water conservancy projects. Therefore, with limited resources, local governments prefer projects with great investment returns and quick results, while the expected return on water conservancy investment is relatively low. Generally, local water conservancy projects are independently set up, approved and invested by local governments. Once local governments have a low preference for such water conservancy projects, it will directly result in a relatively low scale investment in water conservancy. During the investment and construction period, the project cannot be implemented according to the plan if the supporting funds are not enough, although the approval funds are successfully obtained. This will also affect the local governments in the analysis of the reasons that will affect the water conservancy investment and the plan will be changed or even canceled. In addition, the implementation of the project will be hindered if the planning scheme itself is not reasonable. If the same project is applied for funds repeatedly, obviously the implementation of the project cannot be consistent with the planning scheme. In this way, it is

very easy for the investment projects to deviate from the planning scheme, fail to reach the expected target and exert the expected benefits. Furthermore, the fund sources and users of water conservancy investment are scattered in various departments, and the planning of each department is contradictory with each other, which results in partial interests restricting the implementation of the overall plan. In particular, there is a contradiction between the expenditure pressure of financial departments and the dependence of water conservancy departments on financial funds. As a result, departments that directly use funds do not have independent sources of funds. Once the project changes, it is difficult to coordinate and reverse. In the preliminary planning, local governments should give full consideration to the prominent contradiction of the financial funds for local water conservancy and the coordination among various departments, and make plans scientifically, reasonably, and comprehensively.

The very nature of water conservancy projects also influences local government investment. It includes the time delay of investment supply, the uncertainty of investment returns, and the irreversibility of investment. Since the construction period of water conservancy projects is relatively long, the investment scale of water conservancy projects in a short time is large but the benefits are not obvious. Only when the investment and construction is completed and the production capacity is formed can it drive social economy to a certain extent. This characteristic that the current supply cannot meet the current demand leads to an insufficient estimation of the local government's expected investment in water conservancy. The uncertainty of investment returns of water conservancy is determined by the long-term investment cycle of water conservancy. The longer the investment and construction period is, the more uncertainties there are, especially uncontrollable risks will have a great impact on the performance of an investment. For those investors who expect to gain steady returns, their intentions to invest in water conservancy are weak.

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