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Research article

Achieving sustainable soil and water protection: The perspective of agricultural water price regulation on environmental protection

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ABSTRACT

With the development of Chinese economy, more and more attention has been paid to environmental protection, the implementation of water price policy affects economic and environmental changes in China. This paper analyzes the impact of water price policy on agricultural land use and the scale of water pollution discharge in 240 cities in China between 2001 and 2017, by including data from China Urban Statistical Yearbook and China Land & Resources Almanac. The theoretical analysis of this study indicates that the optimal scale of pollution depends on the local initial endowment, economic investment capital and the marginal cost of environmental pollution caused by government's economic activities. Furtherly, the economic activities have a worsening impact on environmental pollution, but when the government implements environmental protection and water price policy measures in response to environmental pollution caused by economic activities, it has a significant impact on the decline in the scale of pollution. The government has promoted the pollution suppression model in the formulation of water prices, which has internalized the external cost of pollution in economic activities and can effectively reduce the scale of agricultural water pollution discharge.

1. Introduction

China is a large agricultural country with a large population. Therefore, agricultural production, food security and farmer's income are all important issues. However, all these agricultural activities are fundamentally related to soil and water resources, which are a necessity for agricultural production. It is obvious that agricultural irrigation water in China is subjected to double pressure from supply and demand. On the supply side, due to the shortage of water resources per capita, uneven distribution between North and South, prominent water pollution and ecosystem degradation, water resource shortage has become an important constraint to social and economic development. At the same time, the rapid growth of industrial and domestic water demand and agricultural irrigation water has formed a fierce competition, leading to a significant reduction in the irrigation water supply.

Although rapid economic changes after China's reform and opening-up have led to an increase in per capita income, the destruction of the natural environment is becoming increasingly serious. The available water resources in economic activities decrease year by year. According to the China Environment Statistical Yearbook (National Bureau of Statistics of China, 2018), China's total water resources in 2018 totaled 2876.1 billion cubic meters. However, it has only increased by 3.83% since 2000, at the same time, water resources per capita have been reduced from 2193.9 cubic meters in 2000–2074.5 cubic meters in 2017, and water available per capita has been declining year by year. The decline of available water resources per capita, the demand for economic activities, and the requirement of natural and ecological environment protection affect the current water utilization in China. In addition, with the growth of Chinese economy and the acceleration of urbanization, the transfer of rural labor force reduces the agricultural labor force, but also increases the demand for agricultural products. The requirements of products inevitably affect the needs of water resources utilization and cost considerations in the production process. Therefore, it has become a meaningful topic for the government to adjust policies to achieve the goals of economic growth, environmental protection, and resource utilization. As the agricultural population in China still

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accounts for the majority, how to increase farmers' income has become an urgent issue. Agricultural income is an important factor that affects farmers' enthusiasm towards grain production, meanwhile, it is also a focus of policy. Since 1978, the income of farmers has increased greatly in rural areas of China (Hong and Sun, 2020). However, all the time, the development of agriculture is still faced with constraints from both financial resources and environmental resources (Jin and Jin, 2020).

As the economy took off, the flow of state finance shifted mainly to the non-agricultural sector. In order to respond, various financial measures were adopted. For example, China has carried out tax-sharing reform for the development of the agricultural sector and promoted the value-added tax of major taxes to deal with the problems faced by agricultural workers since 1994 (Song, 2020). Moreover, as agricultural activities have a huge demand for water, for this reason, water conservation has also become one of the goals need to be achieved. Because water supply needs to invest public resources and has the characteristics of natural monopoly, it is necessary to use government power to conduct price regulation. Since 1994, Chinese government has been promoting various measures related to water price reform, water price improvement, water price subsidies and allowance, with a view to maintaining agricultural output value and reducing the economic burden of farmers. The purpose of agricultural subsidies is to promote agricultural development and protect the interests of domestic agricultural producers. The agricultural subsidy policy is one of the most important agricultural policies in China. Therefore, it is widely discussed by both Chinese and foreign scholars (Wang and Cao, 2008; Sun, 2011; Cui et al., 2017; Love et al., 2019). However, over the years, economic development has brought negative impacts on the environment to a certain degree. Coupled with population growth and other factors that restrict the supply of water resources per capita, government revises water pricing regulations quite frequently. Current studies seldom explored the influence of China's water pricing regulations and policies on water management, especially it's meaning for achieving sustainable soil and water protection.

The current regulation of water price in China originated from the Water Law of the People's Republic of China in 1988, and was amended many times in August 2002, August 2009 and July 2016 respectively. In addition to the regulations of the central government, other departments often launch relevant measures as well. For example, in order to protect the utilization of agricultural water and soil resources, in March 2006, the National Development and Reform Commission and the Ministry of Water Resources put forward the *Notice on strengthening the management of water price in agricultural end canal system*, hoping to carry out the terminal water price system that promotes the metering charge of agricultural water for farmers (Shao, 2019). On the basis of clarifying the property right, clearing up the assets and checking the capital, controlling the personnel and constraining the cost, it shall be checked and approved in accordance with the principle of compensating the operation and maintenance expenses of the agricultural end canal system. From the perspective of economics, this kind of specification is the type of internalizing external cost. Through the pricing mode of water price, the environmental pollution problem can be internalized to promote production. While carrying out economic activities, the management and control of environmental pollution are considered simultaneously, so as to achieve the goal of maintaining sustained economic activities and guaranteeing water and soil resources.

In recent years, the Chinese government has paid much more attention to environmental protection. Basically, relevant improvement programs of water source and water price regulation are launched every year. For example, in 2017, the National Development and Reform Commission and other five departments jointly issued *The Notice on Solidly Promoting the Reform of Agricultural Water Price*, in 2018, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Water Resources and the Ministry of Agriculture and Rural Affairs jointly issued *The Notice on Increasing Efforts to Promote the Comprehensive Reform of Agricultural Water Price*, basically showing an annual adjustment pattern. From this background, it can be seen that China is trying to protect soil and water resources in various regions, agricultural and forestry areas through water price and other policies. The purpose of this study is to analyze the causal relationship between agricultural water price policy and environment, and to explore the impact of water price measures. Referring to studies like Cai and Treisman (2005), Zhang et al. (2011), Yu et al. (2015), this paper considers the impact of regional endowment of Chinese local government, economic capital and water price policies and measures on environmental pollution and focus on water pollution. In the next section, the present study will review previous relevant theories and literature, and clarify the supplementary role of this paper for the past research gap. Then, on this basis, the methodology and research results of this paper will be presented.

2. Literature review

2.1. *Water resources value theory*

Estimating the value of water resources is the premise of setting the price of water resources. Western classical axiology mainly includes land rent theory, labor theory of value, utility theory of value, equilibrium theory of value, etc. (Qin, 2013). On this basis, Gan et al. (2012) summarized the total attribute value of water resources into use value, property value, labor value, and compensation value. Li et al. (1987, 1990, 1991) pointed out that the basic criteria of resource accounting are economic returns and discussed the basic criteria and methods of water resource value accounting to some extent. Some scholars also believed that the value of water resources has time flow, space flow and space-time flow (Zhong et al., 2012). Aiming at the difference between value and price, Jiang et al. (1993) conducted a study and pointed out that the former is essentially the capitalization of the land rent of water resources. To obtain the right of use, water users pay the money amount to the owners of water resources (state or collective, etc.) whether the water resources include human labor or not. The latter is the amount of money paid to the operator when the water user purchases the water, and proposes that the water resource value, production cost and normal profit together constitute the water resource price (Jiang and Wang, 1996). However, in recent years, some scholars have discussed the strategic role of agricultural water-saving on agricultural green development and rural revitalization, and pointed out that the current price of agricultural water is much lower than the value of water resources, and the comprehensive benefit of agricultural water-saving is based on the value of water resources (Ma, 2019). It can be seen that the research on the value theory of water resources is based on the value theory in the field of capital and economy in the early stage, and ecology is gradually considered and become a new trend. Influenced by such cognition and actual demand, countries have gradually begun to reflect the intention of ecological protection and resource conservation in water price setting.

2.2. *China's policy transformation towards sustainable water*

With regard to the issue of how to make water prices in China, the Chinese government has put forward relevant policies in the past. Table 1 summarizes some most important water price regulations and implementation objectives in recent years. In China, various policies mainly refer to the five-year plan. China's related environmental policy changes are mainly compared with the economic activities in the past five years, which are cycled every five years. In the past, China's policies focused on economic growth. However, with the slowdown of economic activities and the deterioration of environmental pollution, in recent years, more and more emphasis has been placed on environmental protection. Under the COVID-19 epidemic in 2020, the Chinese government did not emphasize the economic growth target for the first time, which can be seen as a shift of attention to social and environmental

Table 1
Chinese main water price policy in recent years.

Regulation or Policy	Implementation Year	Goal
National Guidelines on Water Tariffs	1998	The price of urban water consists of water supply cost, expense, tax and 8–10% profit.
Notice on the Key Work of Deepening Economic System Reform	2010	Steadily push forward the reform of water prices, implement a differential pricing system for urbanite water consumption in areas where conditions permit, and advance the comprehensive reform of agricultural water conservation and agricultural water prices.
Water Law of the People's Republic of China	2016	Water use shall be measured in accordance with metering charge and over quota progression add to price system.
Some Opinions on Pushing Forward the Supply-Side Structural Reform in Agricultural Sector and Accelerating the Cultivation of New Drivers of Agricultural and Rural Development	2017	The implementation of water-saving incentives pilot is to give incentives to farmers directly and reward efficient water-saving facilities.

issues. From the perspective of the government, "water" is a kind of public service mainly provided by the government, and the total amount of water resources, distribution of water resources, capacity of water conservancy facilities, social equity of water supply and other issues are inseparable from the public service function played by the government. However, with the development of economy and the impact of various production activities on environmental pollution in the past, the satisfaction of promoting public services is restricted by the level of development and the number of public resources. Therefore, at certain stages, part of public services must be chosen as basic public services to ensure satisfaction. In this context, we can find that the initial goal of the government's water price formulation and measures is not directly related to environmental protection. As mentioned in the introduction, the original goal of carrying out water subsidies, levies or other related systems is to reduce the burden of Chinese farmers. However, with the follow-up development of economy and the deterioration of environment, pollution control has become the direction of government when making water price. In addition, government needs to consider the reduction of water resources per capita simultaneously in the formulation of water price, therefore, the water price regulation is gradually moving towards the goal of water conservation. From the perspective of input-output, the use of water resources in production is an input factor. Reaching the goal of water conservation while maintaining production capacity would help to gain economic efficiency.

2.3. Financial water policy

In terms of fiscal policy tools, subsidy policies have received widespread attention. As China's economy has experienced rapid growth for more than 40 years since the 1980s (Zhang et al., 2017, Chen et al., 2018), the contribution of agriculture to GDP in modern economic activities is relatively small, therefore, agricultural policies were mostly analyzed from the perspective of subsidies. Western scholars have different views on agricultural subsidies. Agricultural subsidies originated from the concept of effective protection. Corden (1966) proposed to measure the degree of agricultural subsidies by the ratio of the difference between the added value of agricultural products in the domestic market and the added value of agricultural products in the international market to the added value of agricultural products in the international market. The comprehensive research on agricultural subsidy system is made by Mccalla (1985), who pointed out that agricultural subsidies should be given. Based on various theories, different scholars at home and abroad have studied agricultural subsidies. The main theories include market failure theory (Zhang, 2012), welfare changes in the economic system (Bahagwati, 2004), public finance theory and agricultural defect theory. The research on China's agricultural subsidy policy mainly involves two aspects: policy design and simulation experiment. The discussion of policy design mainly analyzes the possibility and effect of policy implementation according to the current practice of agricultural subsidies at home and abroad and the requirements of the Agreement on Agriculture of WTO. Based on the features of water resources that exist in the form of water elements and water commodities at the same time, Li et al. (2014) established a computable general equilibrium model (CGE) of water resources which included water production and supply industry, water resource element reward and production water subsidy, three scenarios were established: improving the price of water resource elements, adjusting production water subsidies and technological progress. And Li et al. (2014) discussed the economic and social changes of Jiangxi Province under the goal of water-saving. The results showed that: increasing the price of water resources, reducing production water subsidy and technological progress can improve the efficiency of water use and reduce the total water demand, however, no matter viewed from the index of total output, GDP, employment, price level or the income of residents and enterprises, increasing the price of water resources and adjusting production water subsidy will have negative impacts on the economy. The negative impact of reducing production water subsidy is even greater, however, technological progress can promote economic development while achieving the goal of water conservation.

Wang et al. (2015) simulated and analyzed the impact of agricultural water use efficiency policy and water resource tax policy on the national economy by using the relevant data of 2007 interregional input-output table. The simulation results showed that: the improvement of agricultural water use efficiency can save the production water consumption of each region, and is conducive to economic growth, the policy of levying water resources tax of agricultural sector can also save the production water consumption of each region, but is not conducive to economic growth, from the perspective of saving production water consumption and promoting economic growth, compared with the water resources tax policy, the effect of efficiency policy is better. Besides, the author found that the same policy has different degrees of influence on the regional economic variables, and the direction may also be different, for the demand of production water, the agricultural water use efficiency policy has a greater influence on the northeast, North China, Huang-Huai-Hai and northwest regions, but less influence on the middle and lower reaches of the Yangtze River, Southeast, South China and southwest regions. The policy of water resources tax imposed by the agricultural sector has a greater impact on the northeast, northwest, South China and southwest regions, but a smaller impact on the North China, Huang Huai Hai, the middle and lower reaches of the Yangtze River and southeast regions.

Using Global Trade Analysis Project (GTAP) and its global trade and input-output database, Cao et al. (2012) set different policy projects to simulate the possible changes of Chinese agricultural subsidy policies by designing changes in the total amount of policy subsidy and policy support. The research points out that, increasing the subsidy of Chinese Agricultural Amber Box Policy and the support of Green Box Policy will reduce the overall welfare of China, but will promote agricultural production and import and export trade. Gao and Yin (2016) pointed out that the resource tax of China is a pure mineral resource tax, and its tax setting is determined by the urgency of resource protection and the operability of collection. This study evaluated the burden level of water resource fee from three aspects: the proportion of water resource fee in the unit price of tap water, the proportion of urban water fee in disposable income per capita, and the proportion of water resource fee in the burden of domestic enterprises, and sorts out the existing problems in the collection and management of water resource fee.

2.4. Water conservation

The purpose of water price promotion can be regarded as the internalization of pollution generated by economic activities through pricing, so as to achieve the effect of users and polluters paying. The benefit of its promotion is to achieve water conservation through the implementation of the water price system. The literature points out that the use of water conservation has an impact on agriculture. Huang and Zhang (2020) indicated that most studies discussing the economic and management issues of water and soil conservation employed various econometric models to analyze the factors affecting farmers' decision in adopting the water and soil conservation strategies.

Mathieu et al. (2019) applied a probit model to analyze the factors that determine the adoption of water conservation techniques among Bam cotton producers, the authors concluded that early warning, group membership, smartphone ownership, and cotton income are decisive factors. However, technical assistance and access to the pesticide were negative factors. Kpadonou et al. (2017) applied multivariate and ordered probit models to analyze farmers' adoption-decisions for eleven on-farm water and soil conservation practices in Western African drylands, and the results showed that labor, knowledge and capital-intensive farmers were more likely to make adoption-decisions. Some studies pointed out that water conservation can help increase the output of crops. For example, Bowley (2015) found that wind and water, which were unimpeded by forest cover, would devastate crops, and the soil and water conservation practices promoted by the government, as well as the management of farmland, would improve crop production. Janssen and Swinnen (2019), Zilberman et al. (2019), Huang and Zhang (2020) furtherly concluded that culture is a critical factor that affects water conservation and then causes the influence on the food chain, agricultural supply and other economic behavior.

2.5. Summary

From the above literature review, it can be found that scholars have long studied the value and pricing of water. With the need for a sustainable future, scholars find that China gradually takes the adjustment of water-related financial policies as one of the means to achieve sustainable development. Among these financial policies, water price policy and environmental subsidy policy play an important role. However, due to the limitations of research objects and data, previous literature mostly focused on the implementation of subsidy policies. As a macro policy implemented by a country, the purpose of environmental subsidy is mainly to protect the specific industries of the country, realize the balance between product structure and total amount, guarantee a fair life of producers in the industry, and achieve the goal of environmental protection and sustainable development.

However, the present study found that current literature on water policy pays too much attention to subsidy but ignored the things that happened in the water price. To achieve a sustainable future, the agricultural water price policy in china experienced a huge change between 2001 and 2019 (as shown in Fig. 1). The price policy reform reveals the Chinese government's ambition. In addition to economic development, the government gradually hopes to ensure the rational use of water resources. In particular, the important government documents such as 'No. 1 Central Document' issued relevant instructions on the reform of agricultural water price, which makes the impact of agricultural water price on the environment a question worth discussing.

3. Methodology

The Chinese government or other entities have not announced micro data on water resources such as tax, charge, fee, or other costs related to water resources. The empirical analysis encounters data constraints. Therefore, we analyze the impact of water price norms on the economy and the environment through theoretical construction. In this paper, policy variables are added to the framework of Cai and Treisman (2005), Zhang et al. (2011), and Yu et al. (2015) to investigate the impact of local government's water price policy and changes in local officials on economy and environment. To be specific, it investigates an economy composed of I regions with a central planner and a local government in each region. The total amount of capital owned by the whole economy is $\sum k_i$, k_i represents the amount of environmental investment in the region I. Each region may be different in two aspects: First, the endowment

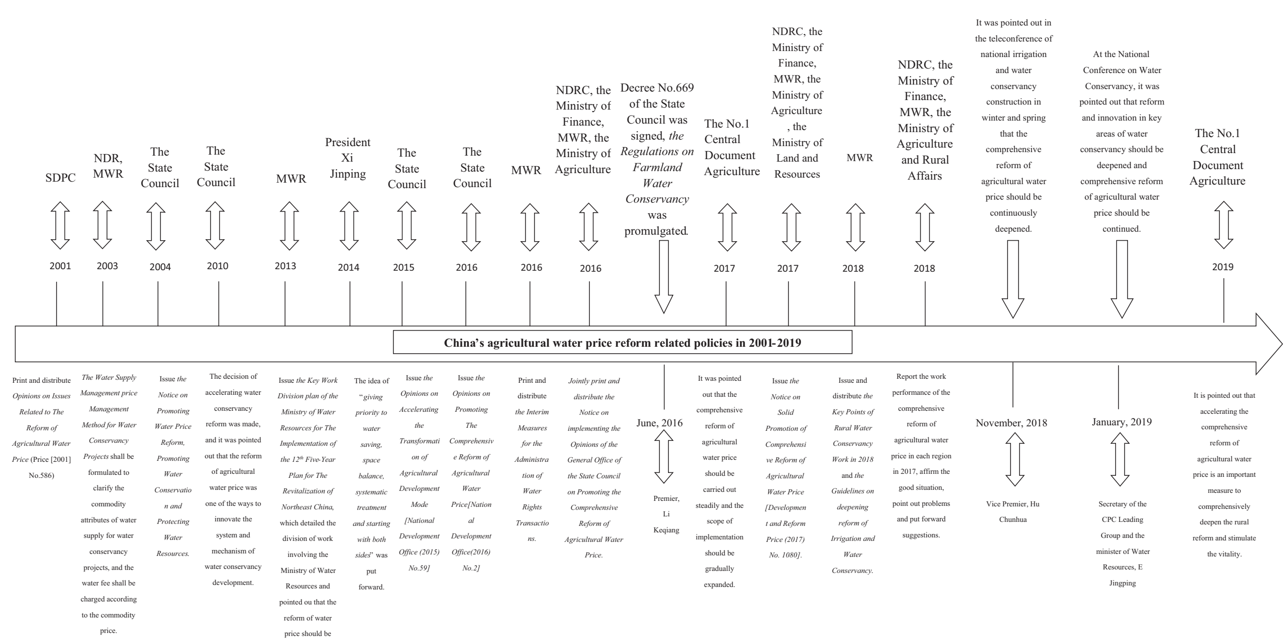

Fig. 1. Relevant Policies of Agricultural Water Price Reform from 2001 to 2019.

of resources, climate and economic basis is different in each region; Second, each local government may adopt different endogenous policies. Local governments carry out relevant environmental protection investment and economic policies and measures through fiscal revenue, fiscal expenditure and the supervision of the central government. In addition, in combination with the government's public water price policy in a specific year, it will have an impact on the water pollution and economic output value of the region. First, the budget of local government can be expressed as formula (1):

$$p_i^1 T_i + \theta_i T_i + G_i = S_i + tY_i + p_i T_i \quad (1)$$

T_i is the amount of environmental pollution caused by agricultural economic activities in the region, Y_i, $\theta_i T_i$ represent the economic output value in the region and the investment or control measures used for pollution caused by agricultural economic activities respectively. In terms of the research subject of this paper, $\theta_i T_i$ is the water price measures in different periods, and the degree of strictness of the implementation of measures (θ_i) is affected by water pollution caused by agricultural activities or whether water resources are insufficient or not (T_i),$\theta_i > 0$. Economic output needs economic activities of supplied land, so p_i^1 and p_i represent the unit cost and land transfer price of local government to prevent and control pollution caused by agricultural economic activities respectively, assuming $p_i \geq p_i^1$.

The utility function of local government is shown as formula (2):

$$U_i^G = U_i^1 + \delta U_i^2 + \varphi U(c_i) = Y_i + \delta G_i + \varphi c_i \quad (2)$$

$U_i^1 = Y_i$ is used to indicate that whether the governor of local government has been promoted or changed, $U_i^2 = G_i$ is the regional economic and environmental performance under the governance. If the economic growth is strong or the environmental protection is effective (for example, the water price policy effectively controls water conservation or the water price regulation internalizes the water pollution, which effectively suppresses the scale of water pollution), it means the policies of current government are effective and the utility level of local governments has been improved. Finally, $U(c_i) = c_i$ is the economic level of the residents on employment in this region. If the macro-economy is improved, so will the income per capita and the overall economic and environmental level.

Assuming that the household budget of residents on employment and the production function of region are as follows:

$$c_i = p_i^0 \left(T_i^0 - T_i\right) + p_i^1 T_i \quad (3)$$

$$Y_i = A_i k_i^{\alpha} T_i^{\beta} \quad (4)$$

A_i represents regional endowment, k_i is the input capital of the regional economy, α and β are the input variant parameters, both of them are greater than 0, $\alpha + \beta < 1$.

By substituting (1) and (3) into (2), the condition for maximizing the utility of local government is as follows:

$$\partial Y_i / \partial T_i = \tau_i(p_i) \quad (5)$$

$\tau_i(p_i) = \left[\varphi\left(p_i^0 - p_i^1\right) + \delta\left(\theta_i + p_i^1 - p_i\right)\right] / (\delta t + 1)$ is the marginal cost of environmental pollution caused by local government's economic activities. Eq. (5) shows that when considering economic activities and environmental protection, the marginal output of the regional land sold for economic activities under the relevant environmental protection measures (such as the amount of environmental investment, water price policy, etc.) is equal to the marginal cost. Then, from formula (4) and formula (5), the optimal pollution quantity can be obtained:

$$lnT_i = \frac{1}{1-\beta}(lnA_i + ln\beta) + \frac{\alpha}{1-\beta}\ln(k_i) - \frac{1}{1-\beta}\ln\tau_i(p_i) \quad (6)$$

Eq. (6) shows that when the local government is faced with the problem of substitution between economic activities and environmental protection, the optimal scale of pollution depends on the initial local endowment ($lnA_i + ln\beta$), economic investment capital ($\ln(k_i)$) and the marginal cost of environmental pollution caused by government's economic activities ($\ln\tau_i(p_i)$). In other words, the scale of regional pollution may be affected by three factors. First, when other conditions remain unchanged, the better the initial endowment is, the lower the cost of economic activity exploitation or resource utilization is, which may lead to resource abuse and pollution aggravation. Second, when more capital is invested in the economic production process, the overall output value is promoted, but the scale of pollution is also increased. Finally, the marginal cost of economic activities is the factor of pollution control. From the research theme of this paper, water price policy or regulation promoted by local government or central government can be regarded as an alternative variable of the marginal cost of environmental pollution. Empirically, based on the data of prefecture-level cities in China, the impact of water price policy on environmental pollution can be further explored.

4. Results

Empirical analysis adopts formula (7):

$$lnT_{it} = a_i + r_1 lnp_{it} + r_2 lnk_{it} + r_3 Policy + r_4 lnCapita_{it} + u_{it} \quad (7)$$

In Eq. (6), we can find that initial local endowment, economic investment capital, and the marginal cost of environmental pollution caused by government's economic activities are the critical factors. In order to compare with the theory implementation and the empirical analyze, we assume variable Wage ($Capita_{it}$) as the proxy variable of $\ln(k_i)$ in Eq. (6), variable lnp_{it} and lnk_{it} reflect the initial local endowment. Finally, due to we cannot find the exact water price criteria, we use the dummy variable as the policy affect. In order to explore the impact of urban water price policy and economic development on soil and water environment, the selection of explained variable lnT_{it} is the discharge amount of water pollution of agricultural industry in prefecture-level cities of China over the years,variable lnp_{it} is the transfer price of urban land supply for economic output, variable lnk_{it} is the amount of financial lending in each city over the years, variable *Policy* is whether water price policy is carried out in the current year, variable $lnCapita_{it}$ is the urban labor income over the years, reflecting the economic level of residents on employment in the region.

It should be noted that why transfer price of urban land supply is used as the variable of economic investment capital. As the Land Administration Law of the People's Republic of China makes local government the only land transfer or in the primary market of the region, the land transfer has become one of the options for local government to raise financial resources quickly. As is pointed out in the document, another factor is that the promotion of Chinese public officials is affected by the performance of economic growth. Accumulating short-term capital while promoting economic activities through land transfer has become one of the strategies for local governments to achieve economic results quickly (Zhou, 2007; Zhang et al., 2011; Yu et al., 2015).

In addition, we also include the variable Change to explore the impact of the change of urban governance team. The empirical data of this paper is from China Urban Statistical Yearbook and China Land and Resources Almanac between 2001 and 2017. The research objects include 240 cities in China. Table 1 summarizes the definitions and descriptive statistics of each empirical variable.

Based on the theoretical analysis above, both economic investment capital and the marginal cost of environmental pollution can explain environmental pollution. Therefore, we test the impact of them on the environment respectively through empirical analysis. In the analysis, considering the income from the sale of state-owned land and control the cost of environmental pollution, we take the deposit balance of financial institutions at the end of the year and whether to implement the water price measures as explanatory variables to explore their impact on the agricultural wastewater discharge. As a result, we will know about which explanatory capacity is stronger, and carry out relevant stability test.

Table 2 summarizes the main empirical results. In order to get reliable results, we use OLS and Random Effects in the analysis process. From the empirical results, when discussing the impact of economic aspect and environmental aspect respectively, it can be found that both of them had significant impact on explanatory variables. First of all, the empirical estimation of OLS 1indicates that variable $lnp_{it}$is significant to the regression coefficient of water pollution discharge being as a positive solution, it is corresponded to intuition that economic activities have a deteriorating impact on environmental pollution. OLS 2 discusses that variable lnk_{it} is significant to the regression coefficient of water pollution discharge being as a positive solution, it can be found that the influence direction is consistent with lnp_{it}. In order to determine the White Test, which is the additional test of OLS 1 and OLS 2 of the empirical estimation combination Table 2 to test, the Omitted variable Test to estimate whether there are missing variables in the combination, and the Variance Inflation Factor to test collinearity. When verifying the original assumption of heteroscedasticity and missing variables that there is possibility to mutate or omit the heteroscedasticity, the estimation results are significant, and the original hypothesis is rejected. According to Nerlove (1963), if the variance influence factor (VIF) is greater than 10, the influence of the estimated variable collinearity is higher. The results show that the VIF values of the other variables are less than 10, indicating that there is no collinearity problem in the overall empirical portfolio.

RE 1, RE 2 of Table 2 extend the empirical combination of OLS 1 and OLS 2, and analyze the influence of each explanatory variable through the panel. In accordance with the results of OLS analysis, it can be found that lnp_{it}, lnk_{it} still had a significant impact on water pollution. It is noteworthy that the environmental protection and water price policy in response to the environmental pollution caused by economic activities had a significant impact on the reduction of pollution scale. Taking RE1 as an example, the estimated coefficient is - 0.033, which was significant. It shows that the water price policy(Policy) or regulation promoted by government has increased the marginal cost of environmental pollution faced by producers in economic activities, and the increase of cost has further restrained the scale of pollution. Through the implementation of water price policy and the cause and effect analysis of economy and environment, it is found that the government is pushing forward the mode of restraining pollution in the formulation of water price, internalizing the external cost of pollution in economic activities, and effectively reducing the scale of urban water pollution discharge.

In order to guarantee the accuracy of the analysis, explanatory variables in Table 3 are analyzed from the perspective of pollution lag. The judgment of the empirical portfolio mainly considers the possible time sequence of policy implementation, we also consider whether the government has changed compared with Table 2. Variable Change in Table 3 analyses when the Secretary of the municipal Party committee changed in the previous year, will it affect the scale of agricultural sewage discharge. The estimation results show that the variable lnp_{it}, lnk_{it} and Policy still have significant influence on the explanatory variables, which is in consistent with foresaid theoretical inference. Second, variable Change is not significant. Through the empirical results, we can infer that the behavior of local governments in land transfer is rational. They want to stimulate economic activities and promote economic growth through land supply. However, in order to suppress the pollution problems caused by economic activities, producers are regulated through the water price policy of internalizing the exogenous cost, which is revealed in the variable Policy that significantly reduces the scale of urban water pollution.

Table 3
Results 1- OLS Estimation.

Dependent Variable	lnT_{it}			
	(1) OLS 1	(2) OLS 2	(3) RE 1	(4) RE 2
lnp_{it}	0.448***		0.113***	0.080***
	(0.015)		(0.013)	(0.013)
lnk_{it}		0.685***	0.077***	0.243***
		(0.016)	(0.023)	(0.031)
Policy	-1.291	0.089	-0.033**	-0.914**
	(0.113)	(0.075)	(0.017)	(0.110)
$lnCapita_{it}$	0.707****	-0.263***	-0.288***	0.052
	(0.055)	(0.071)	(0.040)	(0.061)
Year Dummies	Yes	Yes	No	Yes
Constant	0.924*	0.755	9.425***	3.772***
	(0.514)	(0.593)	(0.179)	(0.672)
N	4075	3861	3795	3795
White Test (P-value)	0.000	0.000		
Omitted variable Test (P-value)	0.000	0.000		
Mean VIF	2.88	3.44		
R square	0.255	0.383	0.244	0.383

Standard errors in parentheses,
* $p < 0.1$,
** $p < 0.05$,
*** $p < 0.01$

Finally, in Table 5 we estimate and compare with the difference of regions. It can be seen from Table 5 that the empirical results are consistent with Tables 3 and 4. The results show that, except for estimation (2), the variable lnp_{it} has a significant positive impact on the explained variable lnT_{it}. The empirical results show that economic activities have a worsening effect on environmental pollution. Secondly, environmental protection and water pricing policies in response to environmental pollution caused by economic activities have a significant impact on the reduction of the scale of pollution. Policy variables have the greatest impact on the eastern region and the least impact on the western region. Similar results are also shown in the estimation of variable $lnCapita_{it}$. It is estimated that when labor wages increase, the impact on the eastern region is the largest at −0.751, followed by the coastal region at −0.482, the central region at −0.480, and the western region at −0.344. Finally, the estimate of the variable Change showed that there was no statistically significant influence on each explained variable.

Table 2
Descriptive statistics.

Variable	Mean	Observations	Definition
Land Price (p_{it})	561,217	4557	Income from the sale of state-owned land in the year (unit: 10,000 yuan)
Water (T_{it})	7054	3922	The amount of agricultural wastewater discharge (unit: 10,000 tons)
Wage ($Capita_{it}$)	31,378	4772	Average annual wage of urban employees (unit: yuan)
Loan (k_{it})	1.940	4233	Deposit balance of financial institutions at the end of the year (unit: 100 million yuan)
Policy	0.235	5661	Dummy variable, if water price policy is proposed in this year = 1, others = 0
Change	0.244	5615	Dummy variable, if the Secretary of Municipal Committee changed in the previous year = 1, others = 0

Source: Collected by this study.

Table 4
Results 2- Robust Check.

Dependent Variable	lnT_{it} (Last year)			
	(1) OLS 1	(2) OLS 2	(3) RE 1	(4) RE 2
lnp_{it}	0.454***		0.101***	0.112***
	(0.015)		(0.012)	(0.013)
lnk_{it}		0.677***	0.047**	0.161***
		(0.016)	(0.022)	(0.027)
Policy	-1.180***	-1.039***	-0.022*	0.047**
	(0.129)	(0.117)	(0.016)	(0.029)
$lnCapita_{it}$	0.978****	-0.244***	-0.090**	-0.212***
	(0.068)	(0.071)	(0.038)	(0.043)
Change	0.012	0.011	0.012	0.011
	(0.035)	(0.032)	(0.016)	(0.016)
Year Dummies	Yes	Yes	No	Yes
Constant	-3.711***	0.645	7.950***	7.258***
	(0.643)	(0.592)	(0.170)	(0.243)
N	3830	3895	3829	3829
White Test (P-value)	0.000	0.000		
Omitted variable Test (P-value)	0.000	0.000		
Mean VIF	3.80	3.92		
R square	0.256	0.366	0.299	0.378

Standard errors in parentheses
* $p < 0.1$,
** $p < 0.05$,
*** $p < 0.01$

Table 5
Results 3- Estimation in Different Region.

Dependent Variable	lnT_{it} (Last year)			
	(1) East	(2) Middle	(3) West	(4) Coastal
lnp_{it}	0.133***	0.052	0.178***	0.154***
	(0.040)	(0.040)	(0.036)	(0.034)
lnk_{it}	0.555***	0.350***	0.335***	0.371***
	(0.048)	(0.045)	(0.051)	(0.045)
Policy	-0.186***	-0.378***	-0.277***	-0.233***
	(0.066)	(0.084)	(0.098)	(0.083)
$lnCapita_{it}$	-0.751***	-0.480***	-0.344***	-0.482***
	(0.087)	(0.082)	(0.085)	(0.085)
Change	0.031	-0.103	-0.035	-0.967
	(0.052)	(0.065)	(0.075)	(0.063)
Year Dummies	Yes	Yes	Yes	Yes
Constant	5.827***	7.341***	3.907***	5.831***
	(0.701)	(0.703)	(0.798)	(0.727)
N	1041	1069	825	1178
R square	0.398	0.151	0.267	0.261

Standard errors in parentheses,
*$p < 0.1$,
** $p < 0.05$,
*** $p < 0.01$

5. Conclusion

In the past 50 years, the world's population and income have increased dramatically, and people have a large demand for clean water and are concerned about whether the supply of water can meet these needs. In the future, people's demand for water will certainly continue to increase, unless we try to reduce demand, so that the growth curve of water supply can be slowed, especially when global warming changes the distribution of rainfall and increases water evaporation. The best way to balance supply and demand is to introduce reasonable water charges. The scarcer the supply of natural resources, the more important the mechanism for efficient allocation of demand. Whether it is now or in the future. In this regard, the available freshwater resources are no different from other scarce resources such as oil or gas. Among them, the word usable is the key point. For example, the problem of global warming has not reduced the world's freshwater, but it has indeed reduced the available freshwater (Becker and Posner, 2009). For instance, in many parts of the world, snowmelt is an important freshwater resource. However, when global warming continues, the pattern of precipitation in many areas has changed from snowfall to rainfall. Compared with snowmelt, rainfall is relatively difficult to collect and distribute. Affected the supply of water resources.

With the development of economy in China, more and more attention has been paid to environmental protection. Among these policies, the implementation of water price policy affected the economic and environmental changes in China. This paper analyzes the impact of water price measures on the scale of water pollution discharge in 240 cities in China between 2001 and 2017 referring to China Urban Statistical Yearbook and China Land & Resources Almanac. This paper analyzes the impact of local government's land sales revenue, deposits balance of financial institutions at the end of the year, and the implementation of water price policy on pollution discharge from the perspective of theory and practice. In theory, this paper indicates that in an economy of political centralization and economic decentralization, the local initial endowment, economic investment capital, and the marginal cost of environmental pollution caused by government's economic activities affect regional environmental pollution simultaneously. Empirically, through panel data, it can be found that environmental protection and water price policy in response to environmental pollution caused by economic activities have a significant impact on the decline of the pollution scale.

This paper argues that local governments in China respond rationally to political incentives through land supply or related economic policies. From the perspective of local government's behavior in land transfer and financial lending, the implementation of such kind of economic policy is the response to the current political incentive mechanism. If the current incentive mechanism is changed, it will have coupling effects on Chinese environment such as cultivated area, environmental conservation, water and soil resources maintenance and other factors. The central government should pay attention to the control of land transfer and the optimization of land use from the design of official incentives. In pursuit of their political achievements during their term of office, local government officials sold agricultural and industrial land at a low price and commercial and residential land at a high price, which results in the loss of land use efficiency and fails to maximize the welfare of subjects of local economic activities. The Chinese government may speed up the improvement of the cadre appraisal program to optimize the structure of land use. Changing the view of political achievements which considers GDP only, adding the assessment dimensions of economic development efficiency and social benefits of economic development could also help. In recent years, the Chinese government has been making water prices towards the goal of water conservation, which can be regarded as the improvement of the government's governance in the social benefits of economic development. Through the internalization of negative environmental externality in economic activities, the pollution discharge problem can be effectively adjusted.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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