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Analysis on the Effect of Transfer Payment on Environmental Governance in Xin'an River Basin

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Abstract

The ecological environment plays a crucial role in human survival and development. Therefore, effective protection of the environment is an essential choice for achieving sustainable development. Our country has vast territory, and water resources are distributed in a complex manner. With the acceleration of urbanization, environmental and economic disparities between regions have widened, and conflicts of interest between upstream and downstream areas of river basins have become increasingly prominent. In recent years, to address water pollution in our country, to address the interests of upstream and downstream areas within river basins, the National People's Congress and other departments have jointly promoted the establishment of an inter-basin ecological compensation system, conducting a series of pilot projects nationwide. The Xin'an River Basin, as China's first provincial-level pilot area for the horizontal ecological compensation system, has been operating for decades, providing valuable practical experience for China's horizontal ecological compensation efforts. This study aims to analyze the operational mechanisms and pathways of horizontal ecological compensation by tracing the development process of the Xin'an River horizontal ecological compensation policy, with the goal of enhancing the effectiveness of horizontal ecological compensation policies and promoting the widespread application of the horizontal ecological compensation model.

Keywords

Ecological Compensation; Transfer Payment; Environmental Governance Effect; Double Difference.

1. Introduction

1.1. Research Background and Significance

After the reform and opening up, the rapid economic development and long-term social stability have also brought serious pollution problems to our country.

In 2022, water pollution beat air pollution for the first time, topping the "pollution category that seriously threatens the public" list with 42.5 percent of the vote. However, due to many subjective and objective reasons, as well as a large number of historical problems, water pollution is still not

The development of the Party has been slow. The report to the 20th National Congress of the Communist Party of China has repeatedly mentioned "respecting nature, adapting to nature and protecting nature", "green mountains and clear waters" and "harmony between man and nature".

According to the statistical data released by the Ministry of Environmental Protection of the People's Republic of China, China discharges a total of 3.5 billion cubic meters of sewage annually. Over 80% of domestic waste is discharged directly into surrounding water bodies

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without proper treatment, turning rivers that are primarily for drainage and secondarily for greening into natural sewers. In particular, there are 2,200 cities and 19,200 counties in China, Wastewater discharge from towns and villages exceeds half of the total, yet their wastewater treatment capacity is significantly lower than the national average. China's environmental protection industry has a total scale of 1269.6 billion yuan, with wastewater treatment accounting for 34%-36% of the total business. Additionally, water pollution control technology in China is expected to improve at a rate of about 15%. Currently, over 80% of domestic wastewater is discharged into water bodies, affecting more than one-third of river basins severely, over 90% of water bodies are seriously polluted, and more than 50% of urban domestic water cannot meet the needs for drinking water. The unreasonable exploitation and use of water resources, especially the worsening water pollution, have led to increasingly prominent water resource shortages and environmental issues in China.

To tackle water pollution, the government has implemented a series of policies and practices. The Xin 'an River is the first provincial ecological protection compensation pilot in China. The Xin'an River, a tributary of the Huangshan River in Anhui, is the source of the Xin 'an River, contributing over 68% of the total water flow to Qiandao Lake in Zhejiang each year. Since the early 21st century, Huangshan has rapidly industrialized and urbanized, leading to the injection of urban wastewater into Qiandao Lake. By around 2010, the water quality had shown a clear trend of eutrophication. As a deep-water lake, Qiandao Lake has a relatively stable water flow gradient and poor self-purification capabilities. When issues arise, controlling them is challenging, posing a serious threat to the ecological security of the region. To protect the water ecology of the Xin'an River, Anhui and Zhejiang have prioritized 'ecological compensation' as the core focus, placing 'ecological protection' at the forefront. They are actively promoting coordinated governance between upstream and downstream areas and have established a provincial ecological protection compensation pilot for the Xin'an River.

This raises the question: What are the mechanisms and pathways through which the horizontal ecological compensation of the Xin'an River affects the ecosystem of the basin? Can this horizontal ecological compensation be extended to other watersheds, and is it sustainable? Therefore, this paper aims to review the implementation process of the horizontal ecological compensation in the Xin'an River Basin, analyze its implementation mechanisms and pathways, and evaluate its outcomes, with the hope of providing valuable insights for China's efforts to build aBeautiful China.

1.2. Research Significance

1.2.1. Theoretical Significance

Based on the theory of public goods and externality, this paper analyzes the mechanism and path of horizontal ecological compensation. Using panel data, empirical analysis is carried out to draw the conclusion that it is not only a supplement and improvement to the construction of ecological compensation system, but also a further exploration of the participation of modern financial system in environmental governance.

1.2.2. Practical Significance

This article evaluates the effectiveness of the horizontal transfer payment policy in the Xin'an River Basin and proposes strategies for establishing a fourth round of cross-boundary ecological compensation mechanism. This will provide empirical evidence and decision-making references for promoting environmental protection and high-quality development in the Xin'an River Basin and the broader Zhejiang-Anhui region, as well as for the reform of related policies in other regions.

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1.3. Literature Review

1.3.1. Research on Environmental Protection Policies

Regarding the implementation of environmental public policies, the international community's research focuses on the environmental impacts caused by local fiscal competition. Li Jinlong[1] suggests that environmental protection policies can lead to regulatory effects on local governments: in pursuit of economic growth, local governments may reduce oversight of polluting enterprises within their jurisdictions and adopt a less stringent approach to environmental regulation. They also attract businesses by offering tax reductions and financial subsidies, which results in increasingly severe local environmental pollution. Zhuang Yuyi[2] et al. argue that environmental protection policies can provide effective incentives for businesses, encouraging them to upgrade their production technologies,

The innovation and application of technology will also reduce the cost of punishment due to pollution, thus producing a squeeze effect.

In our country, the effectiveness of environmental policies has garnered significant attention from both academic and practical circles. The implementation outcomes of environmental policies are influenced by various factors, including the entities responsible for enforcement, the targets of enforcement, and the environment in which they operate. These factors provide both subjective and objective support for the effectiveness of environmental policies, but they can also lead to side effects, causing deviations in the implementation outcomes. Zhao Tianhang [3] et al. suggest that the level of government enforcement significantly impacts environmental spending and the effectiveness of environmental policy implementation, a view that is still debated in academic circles. One reason for this debate is the lack of motivation among local governments to enforce environmental policies, compounded by information asymmetry between different levels of government, which results in low efficiency in implementing environmental policies. Wu Kaishong [4] et al. argue that, based on the 'political game theory,' the current performance evaluation mechanism focuses primarily on GDP growth and increases in local tax revenue. Under the influence of opportunism, local government leaders, while pursuing economic benefits, tend to prioritize economic gains over environmental protection, leading to a loss of environmental awareness [5]. From a rational perspective, when 'interests are exchanged,' local government officials often act in a self-interested manner. The level of 'political potential' varies among different levels of public policy-making units, allowing local governments or implementation units to make informed decisions by analyzing the 'political potential' within policies. Due to the complex political structure and information asymmetry, it is often difficult for the central government to achieve full control over local governments and to gain real-time understanding of them, leading to insufficient enforcement of environmental policies at the local level[6]. Appropriate policies and central government oversight are crucial for effective local environmental governance. 'Performance management' and 'administrative accountability' are key tools for implementing environmental policies. These can enhance the political authority of higher-level environmental departments, reduce interference from peer governments, improve performance evaluation incentives, and reconstruct the government's responsibility value system, thereby creating a favorable environment for the implementation of environmental policies. This helps to overcome obstacles and ensure that environmental policies are effectively implemented and enforced. The effectiveness of the central government in supervising and implementing local environmental policies directly impacts the success or failure of China's environmental governance. While the central government's supervision can have a significant impact, establishing a comprehensive regulatory system is essential for long-term stability. In addition to law enforcement by higher authorities, local environmental regulatory bodies also have the primary responsibility for supervising corporate environmental practices, penalizing environmental violations, and ensuring the basic quality of

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the local environment. The inaction caused by regulatory personnel's negligence is essentially a form of misconduct.

The government subject passively abandons the administrative power, which is a kind of abuse of power in passive posture, and it is another form of administrative corruption [7].

1.3.2. Research on Compensation within the Basin

Basin ecological compensation is a new concept that emerges from the integration of multiple fields, including hydrology, ecology, resource and environmental economics, and law. Wunder[8], Tonetti[9], and Zbinden[10] define basin ecological compensation as the transaction of water ecosystem services between providers and users under ideal market conditions. Pagiola [11] and Savy[12] propose that basin ecological compensation involves compensating and paying for the protection and restoration of water ecosystem services by both the protectors and the polluters. Qian Shuimiao[13] suggests that in the process of water resource extraction and conservation, the relationship between upstream and downstream parties is often imbalanced. Therefore, it is essential to improve this relationship through mutual cooperation between the two sides.

To achieve fairness and justice across the entire region. Scholars such as Shen Manhong [14] have conducted in-depth research on water resource utilization from an environmental economics perspective, suggesting that the externalities of water use can regulate water resource utilization, thereby addressing the 'free-rider' problem and encouraging participation from both upstream and downstream regions. From a policy perspective, Zhou Dajie [15][16] et al. argue that ecological compensation involves protecting ecosystem functions and promoting harmonious development between humans and nature. This is achieved by adjusting the economic interests of stakeholders based on the value or cost of ecosystem services, using government and market mechanisms. Liu Yulong [17], from the perspective of 'co-construction and sharing,' proposed the concept of basin water ecological compensation, which means that the party responsible for ecological damage should bear the responsibility for the damage or provide compensation, while the party benefiting from the ecosystem should share the costs according to the extent of their benefits.

1.3.3. Literature Review

In summary, existing literature on environmental protection policies primarily focuses on the environmental impacts of fiscal competition and the effectiveness of environmental policy implementation. Both domestic and international literature has also defined ecological compensation policies, providing a substantial theoretical foundation for future research in this field and for the continuous improvement of existing systems. This also provides valuable insights and references for this paper. However, studies on transboundary ecological compensation in river basins have mainly focused on the incentive effects of ecological compensation policies and the exploration of laws and institutions, with limited empirical analysis. For the Xin'an River Basin, it is crucial to empirically analyze the environmental governance effects of ecological compensation. Therefore, this paper uses panel data from 27 prefecture-level cities in Zhejiang and Anhui provinces from 2007 to 2018, employing the difference-in-differences method for regression analysis to derive empirical results. The aim is to provide a theoretical basis and data support for enhancing the effectiveness of transboundary ecological compensation policies and promoting the application and promotion of the transboundary ecological compensation model.

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1.4. Research Content and Research Methods

1.4.1. Research Content

According to the research ideas of finding problems, analyzing problems, exploring mechanisms, empirical analysis and drawing conclusions, this paper divides the research content into the following five parts:

First, the relevant literature on transfer payments at home and abroad and horizontal transfer payments is sorted out, the relationship between transfer payments and ecological environment policies is comprehensively evaluated, the core issues of relevant theories are clarified, and the theoretical and empirical issues of relevant theories are sorted out and analyzed.

Secondly, according to the relevant literature mentioned above, the existing related research problems are found and on this basis, my own research ideas are put forward.

Thirdly, by collecting relevant data and using correlation coefficient, double difference model and other methods, the empirical study of ecological compensation in Xin 'an River Basin is carried out. On this basis, the impact mechanism of ecological compensation on ecological compensation in Xin'an River area is revealed.

Fourth, panel data of 27 prefecture-level cities in Zhejiang province and Anhui Province from 2007 to 2018 were selected, and the regression was carried out by using the double difference method, and the test was conducted.

Fifth, on the basis of the above data and empirical analysis, the sustainable development path of Xin 'an River basin is explored, and corresponding policy suggestions are given.

1.4.2. Research Methods

(1) Literature Analysis Method. This method involves using channels such as CNKI and the China Statistical Yearbook to search for domestic and international literature on horizontal transfer payments and ecological compensation in the Xin 'an River Basin, focusing on this topic. It aims to understand the background knowledge of the Xin'an River Basin. By employing a scientific analytical framework, it clarifies the current research status and shortcomings of the Xin'an River horizontal transfer payment policy, providing a logical starting point for future research.

(2) Empirical analysis method. After referring to a large number of literatures, this paper designs the framework of empirical research and uses stata17.0 software to study the effect of horizontal ecological compensation policy (Xin'an River Basin) by using the double difference method.

2. Definition of Relevant Research Scope and Theoretical Basis

2.1. Definition of Relevant Concepts

2.1.1. Ecological Compensation

Ecosystem compensation is a legal system where the state provides economic subsidies to individuals or organizations that positively impact the ecological environment through specific activities, aiming to protect the ecological environment and achieve sustainable development goals. In foreign research, this concept is referred to as 'Payments for Ecosystem Services,' which involves environmental service providers offering the required services to applicants.

In the early stage of China, the principle of ecological compensation is mainly "polluter pays". Although its connotation has been enriched continuously, although many scholars have defined it from various aspects, in essence, it still takes "the user or the destroyer as the price, the protector or the victim as the price" as the basic idea.

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The ecological compensation studied in this paper is the transverse ecological compensation in Xin 'an River Basin, which is based on the method of "the destroyer pays and the victim is compensated", and the transfer payment funds of Anhui province and Zhejiang Province are the main economic compensation methods.

2.1.2. Horizontal Transfer Payments

Transfer payments are the fees that governments or enterprises provide to individuals free of charge to boost their income and purchasing power. There are three types of transfer payment models: vertical transfer payments, horizontal transfer payments, and a combination of both. The costs for horizontal transfers mainly come from fund transfers between provinces and cash transfers among provinces.

This study examines the 'wager' agreements between Anhui and Zhejiang, which are categorized as inter-provincial transfer payments. As China's first pilot for cross-provincial basin transfer payments, this program has achieved significant results after three rounds of nine years of trials. However, it also faces issues such as the unsustainable nature of the' billion-yuan water quality wager,' necessitating improvements in future practices.

2.2. The Theoretical Basis of Horizontal Ecological Compensation

2.2.1. Theory of Externality

When the social marginal cost and the private marginal cost are not aligned, externalities arise. Rational individuals, prioritizing their own interests, tend to favor reducing their private marginal costs. When these two factors are out of balance, they tend to consider issues from a more individualistic perspective, leading to negative externalities. In such cases, the equilibrium does not maximize the overall public interest. Therefore, government intervention is necessary at this point.

The governance of water resources has obvious externalities. If the government increases subsidies for the governance of water resources, improves relevant policies and gives play to the positive externalities of water resources, it will not only improve the local environmental level, but also be more beneficial to the downstream areas

On the other hand, if water resources appear in the form of sewage, it will produce negative externalities and endanger the water resources and economic development of downstream areas. Wastewater discharge has negative external impacts and should be regulated and intervened by the state.

2.2.2. Public Relations Product Theory

"Public goods" is a kind of commodity that is paired with private goods. It is a kind of commodity that has non-competition in consumption or use and non-exclusivity in benefits.

Such as clean air, beautiful environment, national defense to protect the people. If one person benefits from it, many others can also benefit from it. Public goods are non-exclusive, which is a special form of positive externality.

Water resources are a representative public goods, and the market mechanism in the process of using water resources is inefficient to some extent. In order to effectively alleviate this problem, we must rely on the active intervention of the government.

2.2.3. Transaction Cost Theory

Coase first introduced the concept of 'transaction costs,' defining it as the costs associated with obtaining accurate market information and negotiating. As institutional economics and transaction cost theory have evolved, the scope of research has broadened, extending beyond the economic domain to include political areas, such as the formulation and implementation of public policies. Government public policies aim to benefit the region as a whole, ensuring that

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each economy within the region saves costs while implementing these policies, thus achieving a win-win situation for all parties involved.

The core of environmental governance in the Xin 'an River Basin is a regional governance issue, primarily involving the coordination of interests between the governments of Zhejiang and Anhui. The goal is to reduce the transaction costs of cooperation and enhance the willingness of both regions to participate. Currently, China's fiscal system operates under a 'top-down' vertical structure, which clearly defines the financial management responsibilities of each level of government. However, when it comes to revenue distribution among multiple peer-level governments, there are often gaps in institutional arrangements, leading to higher transaction costs. To address this challenge, reforms must be considered at the institutional level, including innovations and expansions in the current vertical fiscal system, such as horizontal ecological compensation.

3. Background of the Horizontal Ecological Compensation Policy in the Xin'an River Basin

3.1. Basic Information about the Xin 'an River Basin

3.1.1. General Information on Physical Geography

The Xin'an River, apart from the Yangtze and Huai Rivers, is one of the few relatively' clean 'rivers in Anhui Province, spanning Anhui and Zhejiang provinces. According to data from the National Bureau of Statistics, the river's inland section in Anhui Province is 242.3 kilometers long, with 54 major and minor tributaries, covering a total riverbed area of 6,440 square kilometers (5,830 square kilometers in Huangshan City and 620 square kilometers in Xuancheng City), which accounts for 55.7% of the total riverbed area. The average annual water flow at the Anhui-Zhejiang border has been 6.53 billion cubic meters for many years, exceeding 68% of the average annual water production of Qiandao Lake (in the middle reaches of the Yangtze River). The middle and lower reaches of the Xin'an River provide invaluable water resources for Qiandao Lake and the Qiantang River.

The middle and upper reaches of the Xin 'an River are dominated by Huangshan City and Jixi County, while the lower reaches are dominated by Hangzhou city in Zhejiang Province. The middle and upper reaches of the Xin’an River are mainly mountainous and hilly areas. Through more than ten years of ecological protection and development, the vegetation coverage of the middle and upper reaches of the Yangtze River has exceeded.

The water conservation capacity has been significantly enhanced by 75%. Huangshan City, located in the middle reaches of the Xin 'an River, is a renowned tourist destination both domestically and internationally. Its abundant water resources have provided substantial water capacity for the development of the Thousand Island Lake Scenic Area and cities like Hangzhou, forming a true' scenic corridor.'

3.1.2. Socio-economic Development

Hangzhou, located in the middle of the country, is known as an 'economic powerhouse.' In 2008, the city's total regional output value (GDP) reached 478.116 billion yuan, with the ratio of the three industries being 3.7:50.0:46.3, and the per capita GDP was 70,832 yuan. Hangzhou's economic and social development has reached a high level, measured by the international standard of an average GDP between 3,000 and 10,000 US dollars. Huangshan City, situated in a water source area, faces industrial development constraints. Although it has established a six-pillar industrial system, including machinery, electronics, and chemicals, these companies are relatively small in scale. The upstream region, due to years of investment in ecological and environmental protection, has a backward industrial structure and has missed out on some development opportunities. Additionally, as investment in ecology and environmental

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protection continues to grow, the economic development gap between upstream regions is widening. For example, in 2008, Huangshan City's GDP was only 0.24 percentage points of Hangzhou City's. Due to its economic lag, Huangshan City's ability to bear the costs of maintaining and reconstructing its ecological environment is significantly reduced, far from meeting the requirements for sustained environmental sustainability.

3.2. Overview of the Horizontal Ecological Compensation Policy in the Xin 'an River Basin

The horizontal ecological compensation mechanism of the river basin is divided into three stages:

In the first phase (2012-2014), the state allocated 300 million yuan annually, with Anhui and Zhejiang provinces each contributing 100 million yuan to establish a compensation fund. If P <1, Zhejiang Province would provide an additional 100 million yuan subsidy to Anhui Province. If P> 1, Anhui Province would provide 100 million yuan to Zhejiang Province. However, the central government would allocate all 300 million yuan annually to Anhui Province for environmental governance.

In the second phase (2015-2017), the national government allocated 400 million, 300 million, and 200 million yuan, respectively, while Anhui and Zhejiang provinces each contributed 200 million yuan as compensation funds. Based on this, the stability factor of the water body, K_0, was increased from an initial 0.85 to 0.89. If P <0.95, Anhui Province would provide 100 million yuan in economic compensation to Zhejiang Province. If P <0.95, Zhejiang Province would provide 100 million yuan in compensation to Anhui Province. If P> 1 or if a severe environmental pollution incident occurs within Anhui Province (as determined by the environmental protection department), Anhui Province would pay 100 million yuan to Zhejiang Province. In all cases, regardless of the circumstances, the central government would transfer all funds to Anhui Province.

In the third phase (2018-2020), state financial support will cease, and each province of Anhui and Zhejiang will contribute 200 million yuan annually to establish a special compensation fund. To implement the policy of 'problem-oriented' and 'stability and improvement,' while maintaining environmental protection, the stability factor for water quality, K_0, has been increased from 0.89 in the previous period to 0.90. Additionally, the weighted factors for the permanganate index, ammonia nitrogen index, total nitrogen index, and total phosphorus index in environmental protection have been adjusted from 0.25 to 0.22,0.22,0.28, respectively, enhancing the effectiveness of environmental protection. If the P value is within the range of 0.95 to 1, Anhui Province will receive an economic compensation of 100 million yuan from Zhejiang Province. If the P value is below 0.95, Zhejiang Province will provide another 100 million yuan in subsidies to Anhui Province. If the P value exceeds 1, or if a significant environmental pollution incident occurs in Anhui Province (as determined by the environmental protection department), Anhui Province will pay 100 million yuan to Zhejiang Province.

4. Empirical Analysis of Environmental Effect Evaluation of Horizontal Ecological Compensation Policy

The 'quasi-public good' nature and 'externalities' of water resources create a 'prisoner's dilemma' between the government and businesses, as both parties seek to secure more resources. Without external interference or incentive and punishment mechanisms, local governments, particularly those upstream, will also lose their enthusiasm for protecting the water environment in the basin.

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On this basis, it is essential to implement a basin ecological compensation system. In China's current administrative management system, the higher-level government holds significant power. Generally, once the higher-level government sets its management goals, the lower-level government is unlikely to refuse these goals. The implementation of the basin ecological compensation system will introduce a new management goal for the upstream region, and it will motivate the staff in the management department to strive for higher performance.

At the same time, the strengthening of environmental regulation may also have a positive impact on the productivity of enterprises. For example, some enterprises

The industry is inefficient and polluting, and after the strengthening of environmental regulation, they will not be able to afford the cost of environmental regulation

Forced out of the market, and the surviving companies can gain a larger share of the market. Secondly, the environmental regulation is strong

Under the regulation, in order to adapt to the intensity of regulation, some enterprises have increased their investment in technology, thus forming the compensation effect of innovation

In addition, under the strategies of "elimination", "retention", "promotion" and "upgrading", enterprises may give up the departments with "low efficiency" to achieve "efficiency" improvement.

4.1. Research Hypothesis

On this basis, the establishment of a watershed ecological compensation mechanism will encourage upstream governments to strengthen the supervision of upstream enterprises, which will not only restrict and motivate upstream enterprises in the agreement; at the same time, the strengthening of environmental control will have a positive impact on the production efficiency of enterprises. Accordingly, the following hypothesis is put forward:

H1: The incentive effect of ecological compensation plays a significant role in promoting environmental governance in the river basin.

According to government statistics, by July 2021, the total investment in the Xin 'an River in Huangshan City had exceeded 19 billion yuan. According to the new compensation agreement, the ecological compensation fees from provinces such as Anhui and Zhejiang totaled only 4.8 billion yuan. The environmental governance costs, opportunity costs, and direct economic losses in the Xin'an River Basin are significantly higher compared to the ecological compensation funds received. Therefore, the ecological compensation policy has certain flaws. The compensation funds in Huangshan City are insufficient to cover the significant economic losses incurred by routine and stringent environmental controls. Based on this, the following hypothesis is proposed:

H2: Due to the large gap between ecological compensation and huge economic losses, horizontal ecological compensation policies are not sustainable.

4.2. Setting and Analysis of Transfer Payment Policy Environment Effect Evaluation Model

4.2.1. Measurement Model Setting

The Xin 'an River Basin is the first provincial basin in China to implement horizontal ecological compensation between provinces, with Huangshan City in Anhui Province and Hangzhou City in Zhejiang Province as the main body. This study takes Huangshan City in Anhui Province and Hangzhou City in Zhejiang Province as the research objects, and other cities in the two provinces as the control group, and establishes the following benchmark model:

$$COD_{it} = \alpha_0 + \alpha_1 post_{it} \times policy_{it} + \lambda\chi + \varepsilon_{it}$$

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Among these, COD represents the oxygen demand of industrial wastewater discharge, commonly used to measure water pollution levels. Therefore, this paper uses COD_{it} as the core explanatory variable to indicate the water resource pollution level of city i in period t. $postit \times policy_{it}$ denotes the interaction term between the Xin'an River Basin Lateral Ecological Compensation Pilot Policy. When a city is part of the pilot program and is designated as an experimental group, it is assigned a value of 1; otherwise, it is assigned a value of 0. X includes control variables such as per capita GDP, infrastructure, and science and technology

Innovation level, proportion of secondary industry, population density and level of foreign direct investment; ε_{it} is the random disturbance error term.

4.2.2. Description of Relevant Variables and Indicators

(1) Dependent variable.The discharge of industrial wastewater pollutants. Improving the water environment quality of the Xin 'an River Basin is a key objective of implementing horizontal ecological compensation, as industrial wastewater significantly impacts the water environment quality of the Xin'an River. Currently, the main pollutants in China's industrial wastewater include solid pollutants, oxygen-demanding pollutants, and organic pollutants. Given this, and considering the availability of data, this paper focuses on the chemical oxygen demand (COD) in industrial wastewater.

(2) Core explanatory variables.The core explanatory variable in this paper is the virtual variable $postit \times policy_{it}$ of the pilot project of trans-boundary ecological compensation, which is used to measure the effect of inter-provincial trans-boundary ecological compensation on the policy of industrial wastewater pollutant discharge.

(3) Control variables.The control variables are denoted as X, primarily drawing from the research of Wu Fengping and Shao Zhiying [18], and Hu Dongbin and Lin Mei [19]. These include: per capita GDP of the region, measured by the city's annual per capita GDP; industrial structure, represented by the proportion of the secondary industry in GDP; infrastructure level, indicated by per capita road area; population density; expenditure on scientific and technological innovation; and the level of foreign direct investment, measured by the ratio of foreign direct investment to GDP.

4.2.3. Sample Selection and Data Sources

This study selects 27 cities in Anhui and Zhejiang from 2007 to 2018, totaling 324 cities as sample observations. The data used are sourced entirely from the China Statistical Yearbook, the China Urban Statistical Yearbook, and statistical materials from Anhui and Zhejiang regions. For any missing data, linear interpolation was employed, and adjustments were made based on provincial data. The descriptive statistics of each variable are presented in Table 1 below.

Table 1. Descriptive statistics of variables

Ariable	Number	Mean	SD	Least Value	Crest Value
COD	324	8.704	0.958	6.097	11.50
DID	324	0.0494	0.217	0	1
IS	324	0.492	0.0894	0.289	0.747
FDI	324	0.0284	0.0209	0.000700	0.0932
PGDP	324	10.83	0.604	9.062	11.93
PINF	324	2.964	0.290	2.114	3.673
PPD	324	6.188	0.515	4.986	6.983
PTC	324	8.599	1.560	4.205	11.58

4.3. Benchmark Regression Results

In this paper, the original sample data obtained are analyzed by double difference regression analysis using Stata17.0 software to estimate the impact of horizontal transfer payment on the

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environmental governance effect in Xin'an Basin. The regression results are shown in Table 2.According to the regression results, the regression coefficient of the pilot ecological compensation dummy variable postit×policy$_{it}$ is-0.77, and P.

The value passed the test, indicating that the policy has a significant effect on the reduction of pollutants in industrial wastewater.

Table 2. Baseline regression results table

	Coef.	Std.	t	P>|t|	[95%conf. interval]
Did	-0.770	0.171	-4.500	0.000	-1.106 (-0.433)
Pgdp	-0.174	0.081	-2.160	0.032	-0.333 -0.015)
Pinf	-0.119	0.134	-0.890	0.376	-0.382 (0.145)
Ppd	-0.144	0.507	-0.280	0.777	-1.143 (0.855)
Pte	0.016	0.035	0.450	0.651	-0.053 (0.085)
Fdi	-3.563	1.725	-2.070	0.040	-6.958 (-0.168)
IS	-0.900	0.670	-1.340	0.180	-2.218 (0.419)
Cons	12.277	3.009	4.080	0.000	6.353 (18.200)

4.4. Parallel Trend Test

The premise of double difference is that the industrial wastewater pollutant discharge of the experimental group and the control group has a similar trend before the implementation of the policy. Therefore, in order to ensure the scientific and accurate regression results, a parallel trend test was conducted.

$$COD_{it} = \alpha + \alpha_{-3}D_{it}^{-3} + \cdots + \alpha_0 D_{it}^{0} + \cdots \alpha_7 D_{it}^{7} + \lambda\chi + \mu_i + \eta_t + \varepsilon_{it}$$

Among them, Dik represents the "event" of implementing the transboundary ecological compensation policy in the watershed as a dummy variable, when the treatment group is in practice

In the kth year before (after) the implementation of the transverse ecological compensation policy for the Shui River Basin, the value is 1; otherwise, it is 0. Other variables are consistent with those in the baseline model. The results are shown in the figure.

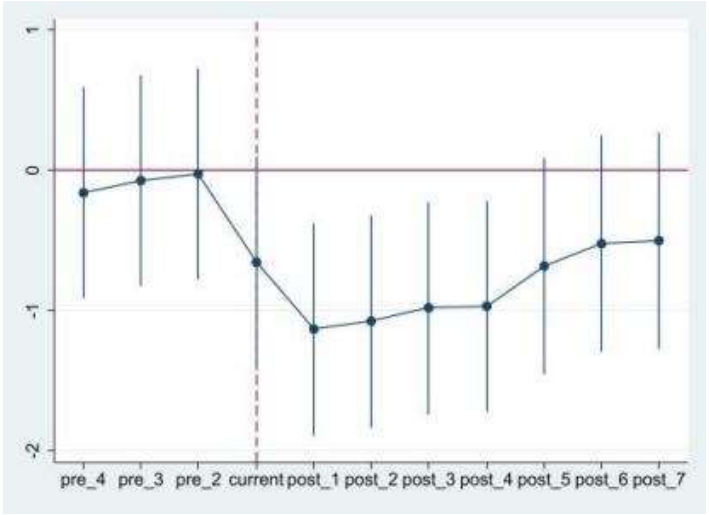

Figure 1. Parallel trend detection diagram

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The research findings indicate that before the policy was implemented, the estimated coefficient for the Xin 'an River Basin was not significantly different from zero. However, after the policy was put into effect, the estimated coefficient for the Xin'an River Basin became significantly less than zero, aligning with the parallel trend hypothesis and supporting the reliability of the baseline regression results. Over the four years of the policy's implementation, there was a noticeable improvement in industrial wastewater discharge within the first few years, but this trend began to decline from the fifth year onward. This also confirms the second hypothesis of the study: the Xin'an River Basin's horizontal ecological compensation policy lacks significant sustainability.

4.5. Robustness Test

At the end of 2013, the Fourth Plenary Session of the 13th Central Committee of Zhejiang Province clearly proposed the Five-Water Co-Governance initiative, with the primary goal of water pollution control from 2014 to 2018. This initiative addressed issues such as 'garbage rivers' and 'black and odorous rivers,' leading to a significant improvement in Zhejiang Province's water environment quality. To prevent the policy from affecting the ecological compensation effect in the river basin, we used Wu Fengping[18]' s method to exclude data from 2014 to 2018 and conducted a double difference empirical analysis, yielding the results shown in Table 3. The $postit \times policy_{it}$ coefficient remained significant at the 5% significance level, indicating that the benchmark regression results remained reliable after excluding the influence of the 'Five-Water Co-Governance' policy.

Table 3. Regression results after excluding other policy disturbances

	Coef.	Std.	t	P>|t|	[95%conf.interval]
Did	-0.819	0.190	-4.310	0.000	-1.194 (-0.444)
Pgdp	-0.042	0.116	-0.360	0.721	-0.271 (0.188)
Pinf	-0.255	0.185	-1.380	0.170	-0.620 (0.111)
Ppd	-1.124	0.771	-1.460	0.147	-2.647 (0.399)
Pte	0.095	0.049	1.940	0.055	-0.002 (0.193)
Fdi	-0.627	3.230	-0.190	0.846	-7.010 (5.755)
IS	-1.947	0.876	-2.220	0.028	-3.678 (-0.216)
Cons	17.400	4.523	3.850	0.000	8.462 (26.337)

5. Conclusion and Suggestions

5.1. Conclusion

This paper uses Stata17.0 software to analyze the relevant data of 27 prefecture-level cities in Anhui province and Zhejiang Province from 2007 to 2018,

A double difference empirical study examines the impact of transfer payments on environmental governance in the Xin'an River Basin. The analysis shows that since the implementation of the horizontal ecological compensation policy within the basin, the signing of ecological compensation agreements between governments has imposed constraints and incentives on upstream regions, leading to enhanced environmental regulations by upstream governments. This has significantly improved environmental governance in the Xin'an River Basin. However, the stricter industrial environmental regulations have also affected corporate production efficiency, resulting in economic losses in the Xin'an River Basin.

In addition to the implementation of policies, research has shown that foreign direct investment has a positive impact on environmental governance in the Xin 'an River Basin. However, the influence of industrial structure and infrastructure levels on environmental governance remains less prominent. Furthermore, during the four years before the policy was implemented,

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the total volume of industrial wastewater discharge increased significantly in a short period, but showed a downward trend in the fifth year. This suggests that the policy effect is not sustained and requires further attention. Therefore, this paper proposes some policy recommendations to improve the horizontal ecological compensation in the Xin'an River Basin.

5.2. Suggestions

5.2.1. Refine the Establishment of a Cross-provincial Watershed Consultation and Cooperation System

Zhejiang and Anhui provinces should strengthen intelligence exchange to ensure long-term and scientific monitoring of water environment quality in border areas

Unified monitoring methods, unified monitoring standards and unified quality control requirements are adopted to obtain scientific water quality monitoring data and realize the exchange of monitoring data for mutual benefit and sharing. On this basis, a regular communication mechanism is formulated once a year to timely report the progress of work and constantly improve the work plan.

Huangshan city and Hangzhou City should further strengthen the cooperation between the upper and lower reaches of the Xin'an River, and strengthen the cooperation between the two cities in the areas of ecological environment, transportation, tourism resources, industrial cooperation and sharing of public services, so as to make new progress.

5.2.2. Raise the Standard of Ecological Compensation Funds

When setting compensation standards, it is essential to consider the upstream governance investment, direct losses, and potential opportunity costs. Additionally, the willingness and ability of downstream enterprises to compensate should be comprehensively evaluated. The compensation calculation system must be scientifically sound to ensure that both upstream and downstream governments, enterprises, and residents recognize the standards, thereby balancing the interests of both parties, combining fairness with efficiency, and using the final calculation results as a basis for friendly negotiations and consultations. In this process, the state should play a coordinating and mediating role and provide necessary financial support. At the same time, the compensation standards should be dynamically calculated and updated as needed based on actual circumstances.

5.2.3. Establish a Water Resources Management System with Multiple Subjects of "Government-Market-Society"

Give full play to the synergistic role of various social resources, and on this basis, form a "government supervision, market driven,

The "public participation" at the core of the watershed ecosystem. First, the state should establish and implement a comprehensive ecological compensation mechanism, strengthen the enforcement and supervision of environmental protection laws; second, it should fully utilize market forces, integrating pollution discharge permits and water rights trading with the ecological compensation system, so that upstream regions can receive not only compensation funds but also additional benefits, addressing the current shortage of compensation funds. Most importantly, it is essential to actively engage the public in the watershed, effectively protect and safeguard the water environment of the watershed.

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