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China's River Chief Policy and the Sustainable Development Goals: Prefecture-Level Evidence from the Yangtze River Economic Belt

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Abstract: The River Chief Policy (RCP), an institutional innovation in China by which top party and government officials assume responsibility for water management, shapes the incentive structure of local governments and may have a huge influence on the Sustainable Development Goals (SDGs). Using a staggered difference-in-difference approach and panel data from 91 cities in the Yangtze River Economic Belt, we estimate the impact of the RCP on an SDG index with eight local-specific indicators. The estimation results show that the RCP has improved the overall SDG index and significantly improved the levels of innovation, education, and consumption. Heterogeneity tests show that more affluent regions are more committed to investing in education, raising consumption, and increasing wages under the RCP. These results suggest that local governments in China have responded rationally and strategically to the RCP. In general, economic growth remains the central goal of local governments, while the strengthening of other responsibilities such as environmental protection will lead to more effort being made to achieve the SDGs during and after the COVID-19 pandemic.

Keywords: River Chief Policy; SDGs; pro-environmental behaviors; staggered DID; prefecture-level data

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1. Introduction

Sustainable development is the core goal for humankind and the central direction of the development policies of the United Nations and various countries. China has experienced decades of rapid economic growth beginning in the 1980s, and problems such as water pollution, air pollution, and ecological damage have become increasingly serious. In order to make China's development sustainable a series of related institutions and polices have been introduced, one of which is the River Chief Policy (RCP).

It is generally believed that the RCP originated from a local government innovation in Wuxi city, Jiangsu province. In 2007, Wuxi's Lake Taihu suffered serious algae pollution, and the RCP was adopted to address the problem. The RCP is a policy in which the main leaders of the local political party and the local government (usually the secretaries of the municipal Party Committee) are appointed jointly as river chiefs to comprehensively take charge of various river governance and protection tasks and to assume corresponding responsibilities. The implementation of the RCP in Wuxi played a significant role in improving water quality. Thereafter, many other local governments have adopted the RCP policy. Given the excellent results achieved in practice in Wuxi, the State Council of China issued the "Opinions on the Comprehensive Implementation of RCP" in 2016 to promote the RCP nationwide. In 2017, the amendment of the Law of the People's Republic of China on the Prevention and Control of Water Pollution officially established the RCP.

From the perspective of institutional analysis, consensus about the effectiveness of the RCP has not yet been reached. Several scholars have found that it is effective in the short term. According to Xiao [1], the RCP appoints the top party and government leaders of the local government as the primary responsible agents for water environment governance within a jurisdiction with clear powers and responsibilities, which is conducive to coordinating the resources of various departments and solving problems. Given the division of power between departments and problems such as passing the buck, engagement in wrangling, and the gradual transfer of accountability pressure between bureaucracies, the RCP can to a certain extent curb the short-term behavior of local government officials who are keen to pursue GDP and ignore the ecological environment, and thereby strengthen local governments' commitment to protecting the ecological environment. Wang and Chen [2] and Wang et al. [3] concluded that the RCP provides effective water management to tackle collaborative issues in the Chinese context, at least in the short term, from the perspective of collaborative governance theory. However, other scholars have questioned the RCP's long-term effectiveness. Huang's [4] institutional analysis concluded that the operation of the RCP is not compatible with incentives and is prone to such problems as slack governance. The administrative accountability of the "one-vote veto" system in which the official whose overall performance is evaluated the lowest would face a great loss if one single item did not meet a certain level is, while very important, not always effective [5]. Ren [6] pointed out that the RCP does not clearly define the division of work among various departments in the process of water governance and relies on vertical authority to coordinate cross-departmental relationships, which helps resolve the fragmentation of the governance structure. Moreover, cross-regional collaboration is essential and RCP might not solve this problem very well. Based on a case study of Foshan city, Liu et al. [7] found that the RCP is not yet well institutionalized and remains a temporary management practice, while its evaluation and accountability mechanism is not optimal; thus, its outcomes depend partially on the commitment and capability of each river chief.

A few years after the RCP was implemented, scholars began to empirically test the effectiveness of this policy. Using a difference-in-differences (DID) approach, Shen and Jin [8] concluded that while the RCP could indeed achieve an initial goal of water pollution control, it could not significantly reduce the level of deep pollutants in water, and its long-term validity had yet to be verified. Researchers found similar results on water pollution and pointed out that the main mechanism might be through upgrading the industrial structure and controlling industrial waste discharge [9], increased investment in wastewater treatment, and faithful enforcement of environmental regulations [10]. On the other hand, different studies have found that the RCP has heterogeneous effects on different pollutants and no significant effect on provincial data [11,12].

Theoretically, the RCP might not only affect indicators related to water pollution. Top leaders of local governments in China are responsible for a series of closely related tasks. The final performance of an agent with multiple tasks under a specific incentive scheme depends on the optimal allocation of effort for each task. Therefore, in addition to directly examining performance indicators related to water pollution, it is necessary to examine the impact of RCP on other indicators. In addition, the local government is regarded as the agent of the central government as well as the agent of the local people to an extent. Other literature on the topic examines popular participation and its effects on the RCP [10,13].

This study focuses on the impact of the RCP as a local institutional arrangement for the Sustainable Development Goals (SDGs), for which we need to construct local-specific sustainability indexes. Many recent studies have systematically investigated how to formulate locality for SDG index compilation [14–17].

From the literature review, it is evident that policy evaluation and analysis of the RCP is mainly focused on its effect on water pollution. There is a lack of comprehensive evaluation of this important institutional incentive, especially evaluation based on the SDG indicators. In theory, it is necessary to explore in depth the systemic impact of the RCP on local government incentives, especially the possible heterogeneity of the impact. This heterogeneity may manifest in two aspects: first, different types of cities respond inconsistently to the RCP; and second, the RCP has different effects on different types of

SDG sub-indicators. The goal of this study is to theoretically identify the impact of the RCP on local-level SDGs and to test our hypotheses using normative econometric methods. In so doing, we derive policy implications for achieving the SDGs during and after the COVID-19 pandemic.

The possible contributions of this paper are: first, evaluating PCR from the perspective of SDGs can give us a richer understanding of the results generated by PCR; second, it can deepen our understanding of the behavior of local governments in China under environmental regulation; and third, to provide evidence for the different trade-offs of different types of local governments in PCR.

The remainder of this paper is organized as follows. Section 2 outlines the hypotheses and empirical approach employed. Section 3 presents the data, variables, and summary statistics. Section 4 presents the results of the basic regression and heterogeneity analysis. Section 5 concludes and discusses the results.

2. Hypotheses and Empirical Approach

2.1. Hypotheses

To analyze the impact of the RCP on sustainable development, it is necessary to analyze changes in the objectives, constraints, and incentive systems of relevant subjects of the policy. Therefore, one should understand the institutional background in China. Following reform and opening up, China can be described as having a "regionally decentralized authoritarian system" [18]. Although the lower-level government may "divert, and resist reforms" of the upper-level government, in general the upper-level government incentive mechanism through personnel and resources is effective, and lower-level governments respond positively to the goals of upper-level governments. Similarly, Zhou [19] defined this system as an "administrative subcontract." This government system involves vertical subcontracting and horizontal (political) competition. Under such an institutional framework, the central government formulates economic and social development goals, and local governments compete for the economic development goals of their jurisdictions. These two theories seem to ignore the initiative of local governments. Yang and Yang [20] pointed out that local governments are motivated to innovate local institutional reforms that actively meet the needs of local economic and social development to obtain political outcomes. In addition, in China's administrative system, apart from economic decentralization, there are many vertical supervision institutions, which are mainly responsible for environmental protection [21–24].

Consequently, China's economy has achieved a decade of rapid economic growth. However, the importance attached by governments to economic growth can easily have harmful repercussions, such as various environmental problems including water and air pollution. Environmental degradation has become an increasingly unbearable problem for Chinese people, and the upper- and lower-level governments have begun to recognize and address it.

It was in this context that the RCP emerged. The RCP was originally an innovative project of a local government in the face of an adverse environmental event, which is in line with the characterization of local government behavior by Yang and Yang [20]. In this reading, although economic growth is the core performance of most local governments, the occurrence of negative events can substantially reduce performance. Therefore, the initiative to adopt the river chief system and give the main government leaders responsibility for the water environment can be viewed as a broadly reasonable response to political performance competition in certain situations. The decision by neighboring places to emulate the system thereafter supports this view.

However, when the central government recognizes and fully implements this policy, it means that it has become an external incentive, and the local government responds to it maximally. Although local governments in China can be considered seekers of political outcomes in a broad sense, the endowments and available resources of different local governments are quite different. Therefore, they may have different reactions to the same incentive scheme.

Local governments in China can be regarded as multi-tasking agents. According to the basic ideas of classic literature, such as Holmstrom and Milgrom [25] and Laffont and Maimort [26], under the same incentive system, the agent's optimal effort is based on measurability, risk characteristics, and interrelationships between tasks for optimal allocation of effort, resulting in different output performance. In addition, when the cost function of the agent is private information, there is a problem of adverse selection.

For local governments in China, the core factor of their performance evaluation system is economic growth along with various related indicators, such as fiscal revenue and corporate innovation. When the central government fully implements the river chief system, it endows the local government with more environmental protection responsibilities. These responsibilities are reflected in a "qualified system," that is, no aggravation of river water pollution, especially no occurrence of serious environmental incidents.

According to the basic idea of the principal–agent model, under this new incentive framework, in general, local governments invest more resources and efforts in projects that can simultaneously promote economic growth and satisfy river water quality. Projects that bring economic growth while harming river water quality are greatly reduced, and projects that are less relevant do not significantly change or face lower investment. In this way, changes in various inputs lead to relative changes in the performance indicators before and after the RCP.

This study examines the performance of the SDGs formulated by the United Nations. This target includes seventeen major items, which are mainly aimed at the national level at the beginning (https://www.un.org/sustainabledevelopment/, accessed on 9 January 2022). A growing number of studies have applied the SDGs to local-level research and practice [14–17]. Based on these studies, and considering the availability of data, this study focuses on eight SDGs. These SDGS aim to end hunger and improve health and well-being, education and lifelong learning, access to drinking water and decent work, and foster industrial innovation and social equality. Their corresponding measurement indicators are shown in Table 1.

Table 1. Eight SDGs and variables.

SDGs	Measurements			
End poverty	GDP per capita			
End hunger	Retail sales of goods			
Health and well-being	Number of beds in hospitals and health per capita	Number of medical and health centers per capita	Green space coverage in built-up areas	Green area per capita
Education and lifelong learning	Number of library books per capita	Number of teachers in primary and secondary schools per capita	Educational expenses per capita	
Drinking water	Treatment rate of sewage plants	Industrial waste water discharge per unit of GDP (-)		
Decent work	Average salary			
Industrial innovation	Advanced industrial structure	Ratio of science and technology expenditure	Number of patents granted per capita	Industrial structure rationalization
Social equality	Urban–rural income gap (-)			

Note: (-) represents a negative indicator.

Among the eight SDGs, industrial innovation can simultaneously promote economic growth and ensure water quality. In this regard, there are few differences among local governments with different endowments. Education seems to be able to promote economic growth and ensure water quality simultaneously. However, education is a long-term investment, and the benefits for different regions vary. China's rapid economic development is accompanied by the migration of people from lower-income regions to higher-income regions. Thus, incentives to achieve both goals by raising educational standards are stronger in high-income areas than in low-income areas.

To reduce water pollution while maintaining economic activity as much as possible, a development orientation relies on consumption and tertiary industry. Consumption depends largely on income; however, the propensity to consume can vary to some extent. Therefore, the government can implement measures to increase the level of consumption to a certain extent. To do this, it is often necessary to allow or take measures to increase income simultaneously, although the increase in wages may increase production costs and reduce economic competitiveness. Considering the combined effect of these two aspects, the adoption of the RCP is expected to significantly increase the level of consumption. Moreover, as there is more room for improvement in the propensity to consume in high-income areas, the RCP is expected to play a more significant role in consumption in high-income areas.

It is difficult for local governments to invest more in the three goals of social equality, health and well-being, and drinking water quality while both maintaining economic growth and maintaining or even improving water quality. Therefore, it can be expected that the adoption of the RCP would not significantly affect these three variables.

Based on the above discussion, the main hypotheses of this study are formulated as follows:

Hypothesis 1 (H1). *The adoption of the RCP leads to an increase in overall sustainability.*

Hypothesis 2 (H2). *The adoption of the RCP increases the level of innovation and education, and the policy effect is more pronounced in high-income areas.*

Hypothesis 3 (H3). *The adoption of the RCP increases consumption levels, and the policy effect in high-income areas is more pronounced. The adoption of the RCP slightly increases consumption levels, and the policy effect in high-income areas is more pronounced.*

Hypothesis 4 (H4). *The adoption of the RCP has no significant impact on social equality, health and well-being, or drinking water quality.*

2.2. Empirical Approach

To estimate the policy effects described in the previous subsection, we used the DID approach. Because the samples entered the treatment groups in different years, it is appropriate to employ a staggered DID approach that allows staggered entry into the treatment group, relaxing the common trend assumption. Following Wooldridge [27], this can be expressed as a cohort-specific event-study regression as follows:

$$Y_{it} = \lambda_i + \gamma_g + \sum_{c=1}^{C} \sum_{p=1}^{P_C} \beta_{cp} D_{cpit} + \varepsilon_{it} \quad (1)$$

P_C refers to the longest duration of the cohort c; D_{cpit} is an indicator variable that indicates whether an observation belongs to cohort c while being processed in period p; and β_{cp} indicates the average treatment effect of period p for cohort c. The estimated average treatment effect is estimated by the following equation:

$$\sum_{c=1}^{C} \sum_{p=1}^{P_c} \beta_{cp} P\left(D_{cpit} = 1 \middle| D_{it} = 1\right) \quad (2)$$

3. Data and Descriptive Statistics

In 2007, Wuxi in Jiangsu initiated the RCP to control algae pollution, with remarkable results. It was implemented as a regular water pollution control policy in the province. Neighboring provinces began to follow suit after noticing its effectiveness. The policy was first implemented in the Yangtze River Economic Belt and continued to expand until it was rolled out nationwide in 2016. This study selected the Yangtze River Economic Belt as the research area because of its representativeness. Figure 1 shows a trend chart for the year in which the cities of the Yangtze River Economic Belt adopted the RCP policy. A few cities that adopted the RCP initiative were excluded because they lack representativeness. Because all samples in 2018 adopted the RCP, the data interception period ranged from 2003 to 2017. Figure 2 shows the number of cities entering the treatment group annually for all the sample data from 2012 to 2018. There were 91 cities in the Yangtze River Economic Belt in total that adopted the RCP in 2018.

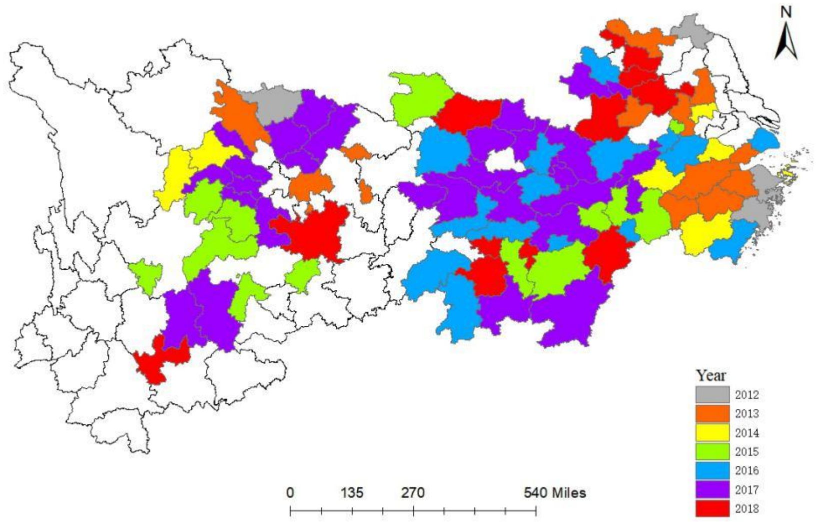

Figure 1. Sample cities and the year they adopted the RCP.

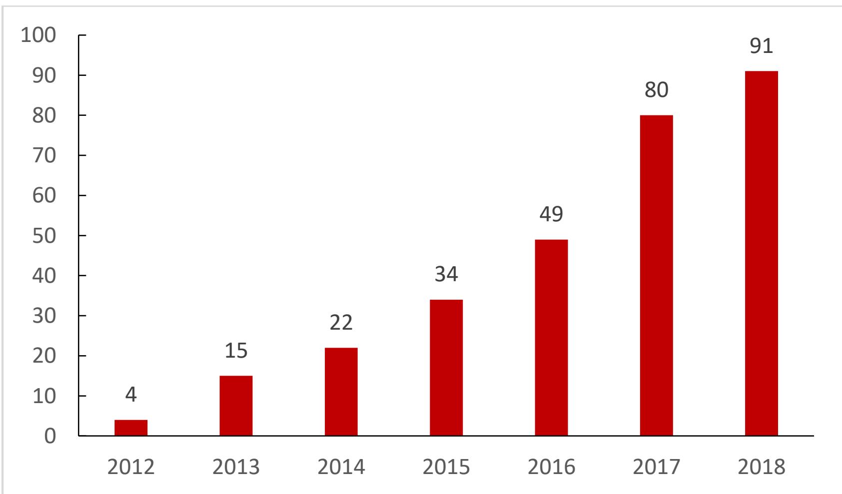

Figure 2. Number of cities that adopted RCP.

The data on the implementation time of the RCP in each city were triangulated using the legal database of Peking University (http://www.pkulaw.cn/, accessed on 5 February 2022), documents released on the websites of local governments, and the Baidu website. Data on population density, number of students in school, GDP, the proportion of science and technology expenditure in fiscal expenditure, loan balance, and deposit balance were obtained from the China Urban Statistical Yearbook. The total import and export value and green space coverage in the built-up area data were obtained from the Wind database (https://www.wind.com.cn/, accessed on 5 February 2022). The per capita number of medical and health centers in each city and per capita library collection were determined according to the relevant data in the EPS database (https://www.epsnet.com.cn/index.html, accessed on 5 February 2022). The per capita patent authorization, industrial wastewater discharge, comprehensive utilization rate of industrial solid waste, and actual foreign investment were from the Guotai'an database (https://www.gtarsc.com/, accessed on 5 February 2022). Urban disposable income and rural net income were collected and organized according to the website of each municipal government. All indicators involving price fluctuations used 2003 as the base year in order to eliminate the impact of price factors. A small amount of missing data was filled by interpolation.

This study adopted the entropy weight method to construct an index of sustainable development. The entropy weight method uses the minimum–maximum normalization method to convert the original data of each index into a dimensionless index evaluation value and then uses the entropy weight method to assign values. This method has been widely used in the compilation of a large number of indexes, and recent studies have used it to compile an SDG index [17,28]. The calculation process is as follows.

(1) Data standardization

Standardize the original data to eliminate the influence of external factors, such as the order of magnitude and dimensions of the indicators. The indicators selected in this study include both positive and negative indicators.

$$\text{positive indicator}: \; y_{\theta ij} = \frac{x_{\theta ij} - \min x_{\theta ij}}{\max x_{\theta ij} - \min x_{\theta ij}} \tag{3}$$

$$\text{negative indicator}: \; y_{\theta ij} = \frac{\max x_{\theta ij} - x_{\theta ij}}{\max x_{\theta ij} - \min x_{\theta j}} \tag{4}$$

$y_{\theta ij}$ represents the standardized score of the j-th indicator of the i-th object in the θ-th year; $x_{\theta ij}$ is the raw value of the j-th index of the i-th object in the θ-th year.

To avoid the problem of 0 values after standardizing the data, we add 0.00000001 to the standardized value.

(2) Data normalization

The standardized data are normalized; d represents a total of d years in the sample and m represents a total of m. cities in the sample.

$$P_{\theta ij} = y_{\theta ij} / \sum_{\theta=1}^{d} \sum_{i=1}^{m} y_{\theta ij} \tag{5}$$

(3) Determine information entropy and index weight

Calculate the information entropy and difference coefficient and determine the weight of each indicator; e represents the information entropy value of the indicator, w represents the entropy weight value of the indicator, and $k = 1/\ln dm$.

$$E_j = -k \sum_{\theta=1}^{d} \sum_{i=1}^{m} P_{\theta ij} \ln\left(P_{\theta ij}\right) \tag{6}$$

$$W_j = \left(1 - E_j\right) / \sum_{j=1}^{n} \left(1 - E_j\right) \tag{7}$$

(4) Construction of composite index

Based on the weights and indicator scores, the sustainability index $Z_{\theta i}$ can be calculated as

$$Z_{\theta i} = \sum_{\theta=1}^{d} W_j y_{\theta ij} * 100 \quad (8)$$

The descriptive statistics of the SDG index calculated according to the above method and other variables are shown in Table 2.

Table 2. Descriptive statistics.

	(1)	(2)	(3)	(4)	(5)
Variables	**N**	**Mean**	**SD**	**Min**	**Max**
D (*Treat*)	1365	0.149	0.357	0	1
year	1365	2010	4.322	2003	2017
GDP_per	1365	9.757	0.793	7.779	12.02
Score (overall SDG)	1365	38.56	9.625	9.605	78.52
wat_s (Drinking water)	1365	71.95	15.86	1×10^{-8}	92.43
inn_s (Industrial innovation)	1365	18.28	7.78	1×10^{-8}	53.23
hea_s (Health and well-being)	1365	41.75	6.839	22.38	70.83
edu_s (Education and lifelong learning)	1365	13.13	6.19	1.363	58.35
consum_s (End hunger)	1365	10.36	10.79	1×10^{-8}	100
sal_s (Decent work)	1365	8.595	6.593	1×10^{-8}	100
cit_coun_s (Social equality)	1365	81.18	8.908	1×10^{-8}	100
stu_ln	1342	10.54	1.279	5.442	13.78
loan	1365	15.73	1.32	13.35	20.23
deposit	1365	16.21	1.243	13.36	20.77
exp_im	1353	0.257	0.519	0.000664	5.238
fdi	1356	0.0493	0.0687	2.96×10^{-6}	1.005
pop_int	1365	475.2	289.9	98.25	2295

Notes: control variables "*stu_ln, loan, deposit, exp_im, fdi, pop_int*" represent "number of student, loan balance, deposit balance, total imports and exports, population density", respectively.

4. Results

4.1. Basic Regression

Benchmark regression results are reported in Table 3. The dependent variable of the regression is the comprehensive SDG index (score), and individual effects and year effects are controlled in all regressions (two-way fixed effect estimation). The results in column 1 (without control variables) and column 2 (with control variables) use the normal DID approach. Columns 3 and 4 report the results of the staggered DID estimation, which considers the overlapping factors. No control variable is added to column 3, while control variables are added to column 4. The key variable, D, has a significantly positive regression coefficient, as shown in columns 1 and 2. The overall marginal effect of the treatment dummy variable of the RCP in the first row of columns 3 and 4 is similar to the regression coefficient of the dummy variable of the river chief system in columns 1 and 2; the overall marginal effect is significantly positive as well. Comparing these regression coefficients, regardless of whether the control variable is added and of whether the overlapping treatment effect is considered the river chief system variable significantly affects the overall sustainable development index, and the coefficient and significance do not vary. It is possible that the result in column 4 provides the best estimation of the marginal effect of the RCP; in other words, on average, the adoption of the RCP increased the sustainability index by 1.191. This result supports hypothesis H1.

Table 3. Basic regressions (DID and staggered DID).

	(1)	(2)	(3)	(4)
	DID		Staggered DID	
Variables	Score	Score	Score	Score
Margin *D*			1.225 ***	1.191 ***
			(0.272)	(0.288)
D	0.974 ***	0.887 ***		
	(0.246)	(0.261)		
stu_ln		0.177		0.244
		(0.224)		(0.222)
pop_int		0.009 ***		0.007 **
		(0.003)		(0.003)
fdi		5.354 **		4.854 *
		(2.498)		(2.488)
loan		0.270		0.299
		(0.423)		(0.425)
deposit		−1.673		−1.208
		(1.144)		(1.133)
exp_im		0.144		0.299
		(0.388)		(0.360)
2004.year	1.277 ***	1.494 ***	1.277 ***	1.397 ***
	(0.145)	(0.261)	(0.146)	(0.256)
2005.year	2.742 ***	3.123 ***	2.742 ***	2.940 ***
	(0.168)	(0.417)	(0.170)	(0.401)
2006.year	3.792 ***	4.305 ***	3.792 ***	4.036 ***
	(0.217)	(0.614)	(0.218)	(0.590)
2007.year	6.098 ***	6.740 ***	6.098 ***	6.394 ***
	(0.230)	(0.750)	(0.232)	(0.719)
2008.year	7.626 ***	8.522 ***	7.626 ***	8.074 ***
	(0.251)	(0.987)	(0.253)	(0.949)
2009.year	9.015 ***	10.262 ***	9.015 ***	9.705 ***
	(0.274)	(1.254)	(0.276)	(1.209)
2010.year	10.919 ***	12.405 ***	10.919 ***	11.743 ***
	(0.276)	(1.460)	(0.278)	(1.411)
2011.year	13.118 ***	14.788 ***	13.118 ***	14.034 ***
	(0.458)	(1.769)	(0.462)	(1.722)
2012.year	14.17 3***	16.033 ***	14.192 ***	15.223 ***
	(0.296)	(1.858)	(0.304)	(1.806)
2013.year	15.790 ***	17.833 ***	15.883 ***	17.022 ***
	(0.297)	(2.012)	(0.318)	(1.961)
2014.year	17.043 ***	19.139 ***	17.151 ***	18.287 ***
	(0.305)	(2.168)	(0.337)	(2.113)
2015.year	18.374 ***	20.759 ***	18.294 ***	19.653 ***
	(0.317)	(2.317)	(0.331)	(2.286)
2016.year	19.494 ***	22.069 ***	19.045 ***	20.610 ***
	(0.315)	(2.481)	(0.290)	(2.421)
2017.year	18.548 ***	21.221 ***	18.294 ***	19.673 ***
	(0.382)	(2.625)	(0.374)	(2.586)
1.dur#1.cohort#c.D			0.143	0.505
			(0.438)	(0.442)
1.dur#2.cohort#c.D			2.121 ***	1.849 ***
			(0.419)	(0.389)
1.dur#3.cohort#c.D			0.699	0.630
			(0.642)	(0.633)
1.dur#4.cohort#c.D			0.366	0.401
			(0.353)	(0.319)
1.dur#5.cohort#c.D			0.570	0.535
			(0.450)	(0.440)
1.dur#6.cohort#c.D			0.556	0.532
			(0.660)	(0.724)

Table 3. *Cont.*

	(1)	(2)	(3)	(4)
	DID		Staggered DID	
Variables	**Score**	**Score**	**Score**	**Score**
2.dur#2.cohort#c.D			1.723 ***	1.685 ***
			(0.581)	(0.517)
2.dur#3.cohort#c.D			0.694	0.307
			(0.721)	(0.725)
2.dur#4.cohort#c.D			1.185 ***	1.135 ***
			(0.377)	(0.349)
2.dur#5.cohort#c.D			0.771	0.719
			(0.493)	(0.479)
2.dur#6.cohort#c.D			−0.037	−0.128
			(0.809)	(0.906)
3.dur#3.cohort#c.D			1.305	1.337
			(0.878)	(0.896)
3.dur#4.cohort#c.D			1.477 ***	1.360 ***
			(0.418)	(0.438)
3.dur#5.cohort#c.D			1.813 ***	1.780 ***
			(0.633)	(0.639)
3.dur#6.cohort#c.D			0.148	−0.002
			(0.829)	(0.903)
4.dur#4.cohort#c.D			2.296 ***	2.386 ***
			(0.735)	(0.728)
4.dur#5.cohort#c.D			2.819 ***	2.685 ***
			(0.674)	(0.679)
4.dur#6.cohort#c.D			0.952	0.784
			(1.021)	(1.112)
5.dur#5.cohort#c.D			2.869 ***	2.509 ***
			(0.859)	(0.876)
5.dur#6.cohort#c.D			1.773 *	1.519
			(1.056)	(1.115)
6.dur#6.cohort#c.D			1.852	1.815
			(1.218)	(1.213)
Constant	27.884 ***	43.360 **	27.884 ***	35.884 **
	(0.204)	(17.074)	(0.202)	(16.558)
Observations	1365	1327	1365	1327
R-squared	0.934	0.936	0.936	0.937
Number of id	91	91	91	91

Notes: *, **, and *** represent significance at the 10%, 5 %, and 1% level, respectively. All regressions are clustered at the prefecture level. Margin Treat (*D*) is the estimation of Equation (2) after the estimation of Model (1). The delta-method standard errors are given in parentheses under the coefficient of Margin Treat, and robust standard errors otherwise; "dur#cohort#D" represents the interaction term of three dummy variables "dur", "cohort", and "D" where "dur" is the categorical variable of the treatment duration, "cohort" is the categorical variable of the treatment cohort, and "*D*" is the dummy variable of treatment group. Dummy variables derived from dur*cohort*D which are empty or omitted in the regression are omitted in the table.

Most of the control variables are not significant; however, this does not mean that they are not related to sustainable development, because the regression controls for multiple fixed effects and there is a complex relationship between these fixed effects and the control variables. Roughly speaking, many control variables can be said to be largely "endogenous" in such fixed-effects regressions such that the coefficients in the regression tend to be less significant, while variables with significant coefficients are likely to be more "exogenous" and indeed can affect the dependent variable. The considerable significance of FDI (Foreign Direct Investment) in the regression seems to reflect this.

4.2. Heterogeneity Analysis

As mentioned above, the impact of the RCP on the comprehensive indicator of sustainable development may manifest as heterogeneity in two aspects: local governments as multi-task agents under the RCP make different efforts in different sub-items, resulting in differences in performance. Local governments with different endowments may make substantially different efforts in response to specific sub-items, resulting in heterogeneity of policy effects for the same sub-item. Here, endowment mainly refers to the level of economic development.

To this end, we examined the policy effects of the RCP on seven sub-SDGs other than GDP per capita. In these estimations, we add GDP per capita and its interaction term to the dummy variable for the treatment group.

Table 4 shows the policy effects of the RCP on innovation and education. The staggered DID estimation results show that the total marginal effect of the treatment group dummy is significantly positive regardless of whether the per capita GDP and the interaction term of the per capita GDP and the treatment group dummy variable are controlled. Overall, RCP adoption boosts local levels of innovation and education. The difference is that in the third column, the interaction term between GDP per capita and the treatment dummy is not significant, while in the sixth column the interaction term between per capita GDP and the treatment dummy is significantly positive. This suggests that the policy effect on innovation is not heterogeneous, whereas the policy effect on education is heterogeneous. From this, we can infer that regardless of the level of economic development, local governments under the RCP are roughly equally committed to promoting the level of innovation. However, local governments in higher-income areas invest more in education than do those in lower-income areas.

Table 4. Heterogeneity (1): industrial innovation and education.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
			Staggered DID			
Variables	***inn_s***	***inn_s***	***inn_s***	***edu_s***	***edu_s***	***edu_s***
Margin *D*	2.082 ***	1.583 ***	1.572 ***	1.995 ***	1.669 ***	1.752 ***
	(0.567)	(0.521)	(0.517)	(0.438)	(0.419)	(0.421)
GDP_per		−7.887 ***	−7.953 ***		−5.151 **	−4.608 **
		(2.820)	(2.888)		(1.973)	(1.889)
D			1.353			−11.697 *
			(7.354)			(6.111)
GDP_per#D			−0.177			1.450 **
			(0.704)			(0.563)
stu_ln	0.174	0.364	0.342	0.529	0.653	0.840 **
	(0.482)	(0.437)	(0.398)	(0.417)	(0.396)	(0.396)
pop_int	−0.009	−0.001	−0.001	0.003	0.009	0.007
	(0.007)	(0.007)	(0.007)	(0.005)	(0.006)	(0.005)
fdi	6.524	4.458	4.427	0.995	−0.354	−0.099
	(4.647)	(3.627)	(3.688)	(1.451)	(1.238)	(1.219)
loan	1.498 ***	1.279 ***	1.272 ***	0.040	−0.104	−0.047
	(0.500)	(0.472)	(0.476)	(0.505)	(0.495)	(0.480)
deposit	−1.550	−1.690	−1.777	−3.393 **	−3.484 **	−2.766 *
	(1.593)	(1.500)	(1.651)	(1.528)	(1.521)	(1.539)
exp_im	−1.178	−1.040	−1.020	0.079	0.170	0.006
	(0.805)	(0.747)	(0.803)	(0.806)	(0.758)	(0.718)
Constant	15.326	86.151 ***	88.316 ***	55.811 **	102.066 ***	84.299 **
	(22.766)	(28.082)	(32.488)	(26.382)	(35.398)	(35.364)
Year	Y	Y	Y	Y	Y	Y
dur#cohort#D	Y	Y	Y	Y	Y	Y
Observations	1327	1327	1327	1327	1327	1327
R-squared	0.803	0.811	0.811	0.180	0.193	0.204
Number of id	91	91	91	91	91	91

Notes: *, **, and *** represent significance at the 10%, 5 %, and 1% level, respectively. All regressions are clustered at the prefecture level. Margin Treat (*D*) is the estimation of Equation (2) after the estimation of Model (1). The delta-method standard errors are given in parentheses under the coefficient of Margin Treat, and robust standard errors otherwise. "Year" represents year fixed effect and "dur#cohort#D" represents all dummy variables derived from dur*cohort*D.

The policy effects of the RCP on consumption and wage levels are reported in Table 5. Staggered DID estimates show that, overall, RCP adoption has significantly increased consumption, with less significant increases in wages. In columns 3 and 6, the interaction term of GDP per capita and the treatment dummy is significantly positive. It can be speculated that all local governments have made efforts to promote consumption under the RCP, which has contributed to raising wages, and more affluent regions are more committed to raising consumption and wages under the RCP. This may indicate that richer regions are better positioned to boost development by boosting consumption, even though labor costs may increase as a result. The RCP drives this trend in wealthy areas.

Table 5. Heterogeneity (2): consumption and salary.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
			Staggered DID			
Variables	***consum_s***	***consum_s***	***consum_s***	***sal_s***	***sal_s***	***sal_s***
Margin *D*	4.964 ***	4.251 ***	4.707 ***	0.793 **	0.525	0.591 *
	(0.997)	(0.975)	(0.876)	(0.311)	(0.350)	(0.345)
GDP_per		−11.262 **	−8.286 *		−4.238 **	−3.809 **
		(4.975)	(4.379)		(1.809)	(1.718)
D			−77.836 ***			−11.730 **
			(13.614)			(4.526)
c.GDP#c.D			7.946 ***			1.146 ***
			(1.301)			(0.387)
stu_ln	−1.759 *	−1.487	−0.466	0.233	0.335	0.483 **
	(0.977)	(0.933)	(0.754)	(0.285)	(0.261)	(0.241)
pop_int	0.035 *	0.047 **	0.040 **	0.015 **	0.019 ***	0.018 ***
	(0.019)	(0.020)	(0.017)	(0.007)	(0.007)	(0.007)
fdi	3.893	0.943	2.343	3.139 *	2.029	2.230
	(4.579)	(3.736)	(3.799)	(1.848)	(1.354)	(1.367)
loan	0.342	0.029	0.338	0.115	−0.003	0.041
	(1.045)	(1.076)	(0.938)	(0.443)	(0.443)	(0.431)
deposit	−13.118 ***	−13.318 ***	−9.384 ***	−1.040	−1.115	−0.548
	(3.246)	(3.239)	(2.907)	(1.256)	(1.250)	(1.162)
exp_im	−1.632	-1.433	−2.331	−0.409	−0.335	−0.464
	(2.714)	(2.571)	(1.852)	(0.869)	(0.820)	(0.683)
Constant	196.768 ***	297.900 ***	200.554 ***	6.283	44.340	30.306
	(48.784)	(66.822)	(59.151)	(22.318)	(32.506)	(30.177)
Year	Y	Y	Y	Y	Y	Y
dur#cohort#D	Y	Y	Y	Y	Y	Y
Observations	1327	1327	1327	1327	1327	1327
R-squared	0.720	0.728	0.770	0.808	0.810	0.811
Number of id	91	91	91	91	91	91

Notes: *, **, and *** represent significance at the 10%, 5 %, and 1% level, respectively. All regressions are clustered at the prefecture level. Margin Treat (*D*) is the estimation of Equation (2) after the estimation of Model (1). The delta-method standard errors are given in parentheses under the coefficient of Margin Treat, and robust standard errors otherwise. "Year" represents year fixed effect and "dur#cohort#D" represents all dummy variables derived from dur*cohort*D.

The policy effects of the RCP on health and well-being as well as on drinking water quality are shown in Table 6. Staggered DID estimates show that RCP adoption had no significant impact on health and well-being or on drinking water quality, and had a less significant negative impact on drinking water quality. This may indicate that under the RCP, local governments have no incentive to be more committed to improving health and well-being, as this outcome cannot be directly reflected in the assessment indicators. Furthermore, drinking water quality and river water treatment may be dealt with under the same budget, with river water treatment squeezing out the budget required to improve drinking water quality.

Table 6. Heterogeneity (3).

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
			Staggered DID			
Variables	***hea_s***	***hea_s***	***hea_s***	***wat_s***	***wat_s***	***wat_s***
Margin Treat	0.153 _	0.006 _	−0.117 _	−2.311 *	−1.601	−1.738
	(0.604)	(0.596)	(0.593)	(1.264)	(1.223)	(1.173)
GDP_per _		−2.313	−2.434		11.229 *	10.334
		(2.622)	(2.626)		(6.353)	(6.422)
D			4.930			24.621 *
			(7.747)			(14.802)
c. GDP#cD			−0.321			−2.389 *
			(0.695)			(1.256)
stu_ln	0.163	0.219	0.177	1.609	1.339	1.031
	(0.574)	(0.575)	(0.573)	(1.557)	(1.527)	(1.522)
pop_int	0.008	0.010	0.011	−0.027 **	−0.039 ***	−0.037 **
	(0.007)	(0.008)	(0.008)	(0.012)	(0.015)	(0.015)
fdi	6.134	5.528	5.471	10.487	13.429 *	13.008
	(3.888)	(3.858)	(3.813)	(7.625)	(8.056)	(7.948)
loan	0.408	0.343	0.331	−1.325	−1.013	−1.106
	(0.781)	(0.807)	(0.810)	(2.200)	(2.223)	(2.226)
deposit	0.655	0.614	0.455	7.611	7.810	6.627
	(2.031)	(2.011)	(2.038)	(5.238)	(5.137)	(5.014)
exp_im	−0.608	−0.567	−0.531	6.612	6.414	6.684
	(0.690)	(0.686)	(0.678)	(4.681)	(4.641)	(4.410)
Constant	16.324	37.097	41.035	−52.568	−153.408	−124.139
	(25.547)	(32.533)	(33.722)	(81.328)	(98.868)	(99.453)
Year	Y	Y	Y	Y	Y	Y
dur#cohort#D	Y	Y	Y	Y	Y	Y
Observations	1327	1327	1327	1327	1327	1327
R-squared	0.448	0.449	0.449	0.763	0.765	0.766
Number of id	91	91	91	91	91	91

Notes: *, **, and *** represent significance at the 10%, 5 %, and 1% level, respectively. All regressions are clustered at the prefecture level. Margin Treat (*D*) is the estimation of Equation (2) after the estimation of Model (1). The delta-method standard errors are given in parentheses under the coefficient of Margin Treat, and robust standard errors otherwise. "Year" represents year fixed effect and "dur#cohort#D" represents all dummy variables derived from dur*cohort*D.

The policy effects of the RCP on the urban–rural income gap are reported in Table 7. Staggered DID estimates show that RCP adoption has no significant impact on the urban–rural income gap. This may indicate that under the RCP policy, local governments have no incentive to be more committed to bridging the urban–rural gap. In columns 2 and 3, the interaction term of GDP per capita and the treatment dummy is significantly negative. This result suggests that wealthier regions that have adopted the RCP have lower incentives to address urban–rural disparities than other regions that have adopted the RCP. These heterogeneity tests confirm hypotheses H2–H4.

Table 7. Heterogeneity (4).

	(1)	**(2)**	**(3)**
		Staggered DID	
Variables	***cit_coun_s***	***cit_coun_s***	***cit_coun_s***
Margin Treat	−0.3 28	−0.057	−0.254 _
	(0.776)	(0.769)	(0.776)

Table 7. *Cont.*

	(1)	(2)	(3)
		Staggered DID	
Variables	*cit_coun_s*	*cit_coun_s*	*cit_coun_s*
GDP_per _		4.287	2.999
		(4.294)	(4.367)
D			35.880 ***
			(11.363)
c. GDP#cD			−3.439 ***
			(1.079)
stu_ln	−0.285	−0.388	−0.830
	(0.666)	(0.669)	(0.646)
pop_int	0.008	0.003	0.006
	(0.010)	(0.012)	(0.011)
fdi	−0.089	1.034	0.428
	(3.875)	(4.395)	(4.212)
loan	0.007	0.126	−0.008
	(0.910)	(0.885)	(0.869)
deposit	4.767	4.844	3.141
	(4.030)	(4.019)	(3.700)
exp_im	0.842	0.767	1.156
	(1.421)	(1.367)	(1.238)
Constant	4.443	−34.057	8.074
	(65.750)	(59.851)	(57.545)
Year	Y	Y	Y
dur#cohort#D	Y	Y	Y
Observations	1327	1327	1327
R-squared	0.478	0.480	0.497
Number of id	91	91	91

Notes: *** represents significance at the 1% level. All regressions are clustered at the prefecture level. Margin Treat (*D*) is the estimation of Equation (2) after the estimation of Model (1). The delta-method standard errors are given in parentheses under the coefficient of Margin Treat, and robust standard errors otherwise. "Year" represents year fixed effect and "dur#cohort#D" represents all dummy variables derived from dur*cohort*D.

5. Conclusions and Discussion

The continuous improvement in the level of sustainable development depends on a series of institutional arrangements that are constantly updated in social dynamics. The RCP, from its inception in Wuxi city to its current status as a nationwide institutional arrangement, has systematically changed China's water pollution governance and even the local government's incentive system. The RCP provides the main leaders of local governments with greater and clearer responsibilities in water environmental governance, and provides a platform and channel for their related governance activities. Local governments' reactions to the new incentive scheme may lead to changes in many aspects of the SDGs by aligning their resources and efforts. This study investigated the impact of RCP implementation on eight SDGs using a staggered DID approach and a range of robustness and heterogeneity tests. The study found that the RCP significantly improved the overall SDG index. The main response of local governments to the RCP system has been to devote more resources to activities that can contribute to both economic growth and pollution reduction, such as improving the level of innovation, upgrading the industrial structure, promoting the accumulation of human capital, encouraging consumption, and moderately increasing wages. Moreover, in terms of certain SDGs, in regions with different incomes the RCP has had different effects on promoting the accumulation of human capital, encouraging consumption, and raising wages. This shows that local governments make trade-offs according to their endowments to maximize their overall performance as evaluated by the central government.

This empirical evidence implies there has been a strategic response of local governments to the newly adopted policy. However, regional differences should be considered when formulating incentive mechanisms. Using the same incentive policy could lead to different behaviors, and might not necessarily maximize policy goals. Specifically, when higher-level governments are guiding lower-level governments to formulate growth and development goals, they should comprehensively weigh the local economic growth potential and the cost of protecting the environment. For areas with high environmental costs in terms of economic growth, the weight of the economic growth assessment should be reduced, while the environmental protection assessment and other weights that contribute to sustainable development should be increased. In addition, an environmental governance coordination and compensation mechanism should be established in order to reach higher achievement levels of the SDGs during and after the COVID-19 pandemic.

Several of the findings of this paper are consistent with conclusions reached in the existing literature, while others can extend the existing literature. Li et al. [11] believed that local governments did not sacrifice their pursuit of economic growth for environmental governance. Although the findings of this study did not negate this conclusion, this study shows that local governments are able to reconcile the conflict between economic development and pollution by adjusting direction to promote economic development under the new environmental regulation. The heterogeneity of local pollution control in China has been shown in the literature [9,29]; the evidence of this study shows that the responses of regions with different economic development levels under RCP have both similarities (efforts to encourage innovation) and differences (promotion of education, consumption and wage levels). Many sources [8,9,11,12] found a reduction in water pollution in rivers under the RCP; however, our evidence suggests that RCP did not improve drinking water quality.

The limitations of this study include the following. First, due to data availability, there is room for improvement in the measurement of SDGs. Second, the mechanism behind the heterogeneity illustrated in this study, especially the tradeoffs on the part of local governments between different items evaluated by superior government, needs to be further examined. Third, because the origin and full implementation of the RCP occurred only a few years ago, the long-term effects of the policy remain to be seen. Furthermore, the policy and its operating mechanism may evolve, which would require further investigation as well.

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