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# Environmental Regulation, Local Government Competition, and High-Quality Development—Based on Panel Data of 78 Prefecture-Level Cities in the Yellow River Basin of China

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**Abstract:** As one of the national strategies of China, the ecological protection of the Yellow River basin (YRB) is vital for the promotion of the high-quality development (HQD) of the regional economy. This paper uses the data of prefecture-level cities in the YRB from 2004–2019 to analyze the effect of environmental regulation and local government competition on HQD. The findings show the following: (1) Environmental regulation can significantly promote HQD in the YRB, and local government competition can significantly reduce HQD. The interaction effect shows that the promotion effect of environmental regulation on HQD weakens with the intensification of competition between local governments. (2) A heterogeneity analysis shows that environmental regulation has a more significant positive impact on HQD for the lower reaches of the YRB. (3) Using a threshold effect test, it is found that the impact of environmental regulation on the HQD presents a significant nonlinear positive effect with an increase in local government competition. When the local government competition represented by the level of economic catch-up exceeds the threshold value of 3.037, this positive effect decreases significantly.

**Keywords:** high-quality development; environmental regulation; local government competition; panel threshold regression model; Yellow River basin



**Citation:** Zhang, Y.; Wang, Y.; Jiang, Y. Environmental Regulation, Local Government Competition, and High-Quality Development—Based on Panel Data of 78 Prefecture-Level Cities in the Yellow River Basin of China. *Water* **2022**, *14*, 2672. https://doi.org/10.3390/w14172672

Academic Editors: Qiting Zuo, Xiangyi Ding, Guotao Cui and Wei Zhang

Received: 28 July 2022
Accepted: 26 August 2022
Published: 29 August 2022



## 1. Introduction

The high-quality development (HQD) of river basins is a concern of various governments, and it plays a vital role in developing the surrounding economy and ecological protection. The 2021 UN Environment report Making Peace with Nature states that "by embodying the value of nature in policies, plans, and economic systems, we can direct investment into activities that restore nature" [1]. However, industrialization and urbanization have caused environmental pollution, resource depletion, and ecological degradation in the Yangtze River, the Yellow River, and other river basins. The contradiction between the "development and protection" of the basin urgently needs to be resolved. The Chinese government attaches great importance to the HQD of river basins. Meanwhile, the government has formulated national strategies, such as ecological protection and the HQD of the Yellow River basin (YRB). The YRB is a critical economic zone in the country. It is a vital area for winning the battle against poverty, and it has an important strategic position in national economic and social development and ecological security construction [2]. As a natural defense system to prevent environmental and ecological security from being damaged, the YRB is of great significance to ecological protection and construction [3]. The report of the 19th National Congress of the Communist Party of China in 2017 stated that "the national economy has shifted from a stage of high-speed growth to a stage of high-quality development". According to "The Outline of the Yellow River Basin Ecological Protection and High-quality Development Plan 2021" released by the Central Committee of the Communist Party of China and the State Council, the principles of ecological protection and HQD must be grasped in the YRB, ecological priority must be adhered to, green development must be boosted, and the road of sustainable HQD must be taken. The YRB suffers from water shortages, severe environmental pollution [4,5], insufficient livelihood development, and significant regional differences in resource endowments [6]. The economic connections of the provinces and regions along the Yellow River are low, and the HQD is insufficient [7]. In the process of promoting HQD, environmental regulation, as an essential means of controlling pollution and reducing emissions, can motivate the technological renewal of the enterprise [8]. It plays a vital role in the win–win process of economic growth and ecological protection in the YRB. Therefore, it is of great theoretical and practical significance to build a comprehensive evaluation system for HQD in the YRB and to make reasonable measurements in order to clarify the impact of environmental regulation on HQD.

Currently, the literature on HQD focuses on the definition of connotation and the construction of the evaluation index system. HQD encompasses high-efficiency, fair, green, and sustainable development, and its goal is to meet people's growing needs for a better life [9,10]. There are two methods for measuring the HQD index: the first method is the measurement of a single indicator. HQD is mainly measured by indicators, such as total factor productivity [11,12], value-added rate [13,14], the intermediate input–output ratio of enterprises, investment efficiency, and labor productivity growth [15,16]. In addition, with the increasing attention to resource and environmental issues, many scholars have constructed indicators of green/ecological total factor productivity [17,18]. The second method is measurement based on the comprehensive index system. However, a unified evaluation system has not yet been formed. Most existing studies have constructed an evaluation index system based on the new development concept of "innovation, coordination, green, openness, and sharing" [8,19,20].

Regarding the research on environmental regulation and economic development, there are three main viewpoints. The first viewpoint is based on the "Porter Hypothesis", which holds that environmental regulation promotes the improvement of the economic level [21,22]. The implementation of environmental regulation policies will stimulate scientific and technological innovation, thereby driving the improvement of total factor productivity and offsetting the environmental governance costs of enterprises. Therefore, enterprises will improve production technology, promote production technology into clean technology, and realize the transformation and upgrading of industrial structure. Ultimately, this will drive the HQD of the regional economy [23]. In addition, some scholars have explored the heterogeneity of environmental regulation on economic growth and found that environmental regulation has a significant role in promoting HQD in the central and eastern regions of China, though it has no significant impact on the western region [24]. In addition, some scholars found an obvious mutual promotion relationship between environmental regulation and economic growth [25,26]. The second viewpoint is based on the following cost effect, which holds that environmental regulation hinders the improvement of the economic level [27,28]. In the short term, enterprises will need to invest much human and material capital in technological innovation. This will lead to enterprises' costs far exceeding the economic benefits. Therefore, enterprises will lose their enthusiasm for green investment [29]. The third viewpoint is the nonlinear relationship, showing an "inverted U-shaped" relationship [30,31]. There is heterogeneity between regions. There is a cost effect in eastern China, an innovation compensation effect in central China, and the strengthening of environmental regulations in western China will inhibit economic growth [32].

The research on local government competition focuses on discussing whether the central government should decide on environmental issues in a centralized or local government in a decentralized governance model. Due to the public nature and externality of the environment, the benefits obtained by local environmental governance will spill over to neighboring governments, and the responsibility for environmental pollution will be shared by neighboring governments, resulting in the "free-rider" phenomenon [33].

In addition, local governments tend to relax environmental regulations to compete for liquid capital, resulting in an environmental "race to the bottom" between regions [34]. Woods [35] found that the state governments in the United States relaxed environmental regulations to attract external companies, resulting in environmental degradation. Some studies have proven the existence of a "race to the bottom" in China's local government environment [36–38]. In the eastern region of China, local government competition can improve the neighboring ecological environment, but in the central and western regions, it will aggravate the neighboring environmental pollution [39]. The rapid development of China's economy benefits from a vertical political management system and economic decentralization [40]. Under this system, GDP is an essential basis for promoting officials, so it plays a considerable incentive in improving local economic development [41]. However, it will lead local governments to pay more attention to short-term political performance and to ignore long-term economic growth [42]. In addition, to receiving a promotion, officials will implement looser environmental governance methods to attract foreign or local enterprise investment [43], which results in regulatory failure and environmental degradation [44]. This is not conducive to the coordinated development of the economy–ecology–environment, which is not conducive to improving HQD.

In summary, the existing studies have both theoretical and empirical levels. However, there are still certain deficiencies: (1) Although there have been many explorations of the measurement of HQD level, due to the short time since it was proposed, the theoretical basis for the construction of HQD indicators is insufficient. In the selection of indicators, many indicators reflect economic development, industrial structure, and growth rate, while few reflect the improvement of people's livelihoods. (2) Most of the existing literature focuses on the one-way relationship between environmental regulation and economic growth or between local government competition and economic growth. However, there are few studies on environmental regulation and HQD from the perspective of local government competition. Therefore, this paper uses the data of prefecture-level cities in the YRB from 2004–2019 to empirically analyze the effect of environmental regulation and local government competition on HQD.

Based on the above analysis, this paper proposes the following research hypotheses:

**Hypothesis 1 (H1).** *Environmental regulation can improve the HQD level of the YRB.*

**Hypothesis 2 (H2).** *Under the effect of local government competition, the role of environmental regulation in promoting HQD in the YRB is weakened.*

**Hypothesis 3 (H3).** *The impact of environmental regulation on the HQD of the YRB presents a nonlinear characteristic with the enhancement of local government competition intensity.*

## 2. Materials and Methods

### *2.1. Research Scope and Data Sources*

The Yellow River is the second largest river in China, with a total length of 5464 km. It originates from the Qinghai–Tibet Plateau, flows through nine provinces (autonomous regions) from west to east, and flows into the Bohai Sea in Dongying City, Shandong Province. There are huge differences in the topography and landforms in the basin, large differences in altitude, and obvious differences in the natural environment. The YRB is a belt rich in energy resources, with obvious advantages in hydropower, coal, oil, and natural gas, and it has rich and diverse mineral resources. The natural conditions of the YRB and the regions it passes through are very different, and the economic development is unbalanced. For example, the total GDP of Shandong Province in 2020 is 24.33 times that of Qinghai Province. The problem of unbalanced and insufficient development between regions is prominent. In addition, the YRB has various ecological function types and various nature reserves, and it is the ecological security and ecological optimization belt in China.

The YRB includes nine provinces (autonomous regions). Among them, there is a serious lack of data on Haidong City and autonomous prefectures; Sichuan Province only flows through a small area of the YRB; Inner Mongolia's Dongsimeng belongs to the broad northeast region; Laiwu City was merged into Jinan City in Shangdong Province in 2019. Therefore, this paper excludes the above cities and selects 78 prefecture-level cities in the YRB as the research objects. Maps were generated using ArcGIS 10.8, as shown in Figure 1. The data mainly come from the "China Environmental Statistical Yearbook", "China Urban Statistical Yearbook", the statistical yearbooks of various cities, the National Bureau of Statistics website, and the EPS database.

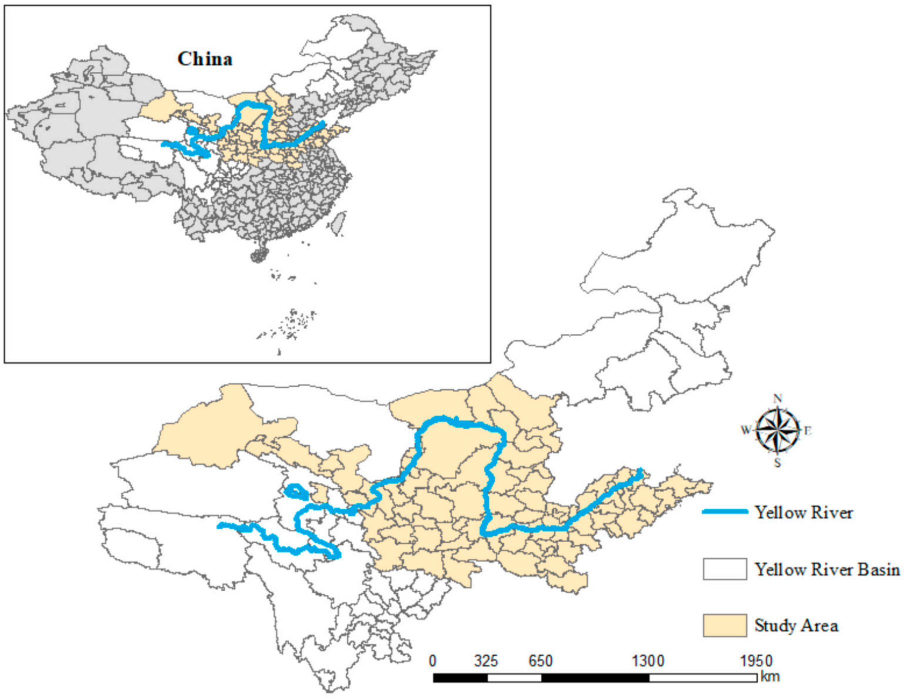


**Figure 1.** Map of the study area.

### *2.2. HQD Index System*

#### 2.2.1. Meaning of HQD

The current research has not yet uniformly defined the connotation of HQD. Starting from the goal of HQD, the connotation of HQD is efficient, fair, green, and sustainable development aimed at meeting people's growing needs for a better life [10]. HQD is the economic development mode, structure, and dynamic state that meet the real needs of people's growth [7]. From the perspective of the "five development concepts" and the main social contradictions, HQD is defined by identifying imbalances and inadequacies in economic and social development [45]. As a typical river basin flowing through China's nine major provinces and regions, the YRB requires HQD based on the full consideration of various factors, such as the natural ecological environment and economic structure characteristics of the basin, guided by systematization, integrity, and relevance, as well as the benign interaction and coordinated development of economy, society, and the ecology in the whole basin [2].

#### 2.2.2. Calculation of HQD

The entropy method is an objective weighting method, and it analyzes the role of the comprehensive evaluation by comparing the information entropy of the indicators [46]. Chen et al. [47] used the entropy weight method to calculate the weight of each index and to evaluate the urban ecological level on the basis of analyzing the characteristics of the entropy weight method in different stages in detail. Thus, this paper also uses the entropy weight method [46–48] to measure the HQD level of the 78 prefecture-level cities in the YRB from 2004 to 2019. The specific steps are as follows:

First, this paper performs extreme value standardization on the original dataset. The positive index is $X'_{ij} = (X_{ij} - \min(X_{ij}))/(\max(X_{ij}) - \min(X_{ij}))$, and the negative index is $X'_{ij} = (\max(X_{ij}) - X_{ij})/(\max(X_{ij}) - \min(X_{ij}))$, where $X_{ij}$ is the index value of the original data, and $X'_{ij}$ is the standardized index value. Then, it calculates the contribution of the $i$ evaluation object under the $j$ index with the formula $P_{ij} = X_{ij}/\sum_{i=1}^{n} X_{ij}$. Next, it calculates the entropy value with the formula $E_j = -k\sum_{i=1}^{n} [P_{ij} \times \ln(P_{ij})]$, where $k = 1/\ln(n)$. Later, it calculates the weight of the $j$ indicator with the formula $W_j = (1 - E_j)/(\sum_{i=1}^{n} (1 - E_j))$. Lastly, it calculates the HQD index of the $i$ evaluation object with the formula $Y_i = \sum_{i=1}^{n} (W_j \times P_{ij})$.

### 2.2.3. Index System Construction

The selection of indicators in this paper is based on the principles of comprehensiveness, systematicness, objectivity, and data availability. Drawing on the research ideas of Liu et al. [24] and Lin et al. [49], this paper constructs 25 evaluation indicators from the four dimensions of HQD, including the driving force, structure, method, and achievement, and establishes a scientific, fair, objective, and practical indicator system for HQD in the YRB, as shown in Table 1.

**Table 1.** Index system for evaluating the level in the Yellow River basin.

| Criterion Layer | Element Layer | Indicator Layer | Unit | Indicator Attribute |
|---|---|---|---|---|
| Driving force of HQD | Technological progress | R&D investment intensity | % | + |
| | | Science and Technology Expenditure/Financial Expenditure | % | + |
| | Human capital | Per capita education expenditure | RMB/per capita | + |
| | | Number of students in colleges and universities/total population of the region | per capita | + |
| Structure of HQD | Industrial structure | Added value of the tertiary industry accounts for the proportion of the regional GDP | % | + |
| | Financial structure | Ratio of deposits and loans of financial institutions to GDP | % | + |
| | Urban and rural structure | Ratio of per capita income of urban and rural residents | % | – |
| | | urbanization rate | % | + |
| | Trade structure | Proportion of foreign investment in regional GDP | % | + |
| Method of HQD | Save resources | Energy consumption per unit of GDP | ton/10,000 RMB | – |
| | | Electricity consumption per unit of GDP | kWh/10,000 RMB | – |
| | Environmental protection | Comprehensive utilization rate of industrial solid waste | % | + |
| | | Harmless treatment rate of domestic waste | % | + |
| | | per capita water resources | $m^3$ | + |
| | | Urban per capita park green space | $m^2$ | + |
| Results of HQD | Economic development | GDP per capita | RMB | + |
| | | Fiscal revenue as a percentage of GDP | % | + |
| | | Urban registered unemployment rate | % | – |
| | Public service | Number of public libraries per 10,000 people | | + |
| | | Public transport vehicles per 10,000 people | | + |
| | Social security | Medical facility beds per 1000 people | | + |
| | | Number of people participating in pension insurance | 10,000 people | + |
| | Environmental cost | Wastewater discharge per unit of output | ton/10,000 RMB | – |
| | | Sulfur dioxide emissions per unit of output | ton/10,000 RMB | – |
| | | Smoke (powder) dust emission per unit of output | ton/10,000 RMB | – |

In terms of the driving force of HQD, it is divided into two element layers: technological progress and human capital. It mainly reflects the transformation of economic development from factor-driven to innovation-driven relying on human capital, which is an important symbol of HQD and the cornerstone of ensuring green, fair, and sustainable development. Therefore, the level of technological progress and the level of human capital are measured here. The level of technological progress is measured by the intensity of R&D expenditures and the proportion of scientific and technological expenditures in fiscal expenditures to the total population of the region.

In terms of the structure of HQD, the proportion of the added value of the tertiary industry in the regional GDP is used to reflect the changes in the industrial structure. The proportion of deposits and loans of financial institutions in the GDP is used to measure the changes in the financial structure. The ratio of the per capita income of urban and rural residents and the urbanization rate reflects the urban and rural structure. The proportion of foreign investment in the regional GDP reflects the level of economic opening to the outside world.

In terms of the method of HQD, it is divided into two element layers: resource conservation and environmental protection. In terms of resource conservation, the energy consumption per unit of GDP and electricity consumption per unit of GDP are selected to represent the main indicators of resource conservation by economic activities. The per capita area of park green space represents the main indicator of economic activities for environmental protection.

In terms of the results of HQD, the per capita GDP is used to measure the level of economic development, the proportion of fiscal revenue to GDP is used to measure the quality of economic operation, and the urban registered unemployment rate is used to measure the impact of economic fluctuations on people's living and welfare. Indicators, such as the number of public libraries per 10,000 people and the number of public transport vehicles per 10,000 people, are used to measure multi-dimensional social life. Indicators such as the number of beds in medical institutions per 1000 people and the number of people insured by endowment insurance are used to measure social security. In terms of environmental cost, the amount of wastewater discharged per unit of output, the amount of sulfur dioxide discharged per unit of output, and the amount of smoke emissions (dust) are used to measure the damage to the environment caused by economic activity.

### *2.3. Empirical Strategy*

#### 2.3.1. Benchmark Regression Model

Based on the above theoretical analysis, to empirically explore the impact of environmental regulation and local government competition on HQD, this paper uses the data of prefecture-level cities in the YRB from 2004 to 2019 to construct the following measurement model:

$$HDQ_{it} = \alpha_0 + \beta_1 ER_{it} + \beta_2 ER_{it} \times \ln GOV_{it} + \beta_3 \ln GOV_{it} + \sum \delta \ln X_{it} + \mu_{it} \quad (1)$$

where $i$ represents the prefecture-level city, and $t$ represents the time. $HDQ$ is the level of high-quality development; $ER$ is the environmental regulation; $GOV$ is the local government competition; and $ER \times GOV$ is the interaction term between environmental regulation and local government competition. $X_{it}$ is the control variable that affects the level of HQD; and $\mu$ is a random disturbance term. $\ln GOV$ is in logs.

#### 2.3.2. Threshold Regression Model

The relationship between environmental regulation and HQD is also different depending on the intensity of the competition between local governments. Existing studies mostly draw linear conclusions [22,24]. According to the above theoretical analysis, environmental regulation, local government competition, and HQD have interactive effects. Therefore, it is not accurate to test the effect between them with a simple linear relationship. In order to verify the nonlinear relationship between environmental regulation, local government competition, and the HQD of the YRB, this paper uses a nonlinear threshold panel model for this research. The threshold regression model was developed by Tong in 1978 and further improved by Hansen in 2000 [50,51]. This paper further uses local government competition as the threshold variable and adopts the method of Hansen [51] and Ding et al. [52] to test the threshold effect. When the model only has a single threshold,

$$HQD_{it} = \alpha_0 + \sum \delta \ln X_{it} + \beta_1 ER_{it} \times I(\ln GOV_{it} \le r_1) + \beta_2 ER_{it} \times I(\ln GOV_{it} > r_1) + \varepsilon_{it} \quad (2)$$

In many cases, there are multiple thresholds, so the extended multi-threshold model is constructed as follows:

$$HQD_{it} = \alpha_0 + \sum \delta \ln X_{it} + \beta_1 ER_{it} \times I(\ln GOV_{it} \le r_1) + \beta_2 ER_{it} \times I(r_1 < \ln GOV_{it} \le r_2) + \beta_3 ER_{it} \times I(\ln GOV_{it} > r_2) + \varepsilon_{it} \quad (3)$$

where $\ln GOV$ is the threshold variable, $r$ is the threshold value, and $\varepsilon$ is the residual item.

### 2.4. Variable Selection and Descriptive Statistics

#### 2.4.1. Explained Variable

The explanatory variable in this paper is the high-quality development level (HQD). This paper uses the entropy method to construct an indicator system for HQD in the YRB from four dimensions, namely, the driving force, structure, method, and achievement of HQD, as shown in Table 1.

#### 2.4.2. Core Explanatory Variables

Environmental regulation (ER): This is a general term for the "policies, regulations, measures, and means" promulgated and implemented by the government or related organizations. Currently, the measurement of environmental regulation is mainly divided into two categories: the single index method and the comprehensive index method. Single indicators mainly include pollution fee collection [53], single pollutant discharge or treatment efficiency [54,55], environmental treatment costs [56,57], and environmental protection regulations and standards [58,59]. The comprehensive index method selects indicators from different angles. It constructs comprehensive indicators, such as various pollutant removal rates [60,61], environmental taxes and fees [62], and environmental input [63], by weighting using the entropy weight method and factor analysis method. This paper combines the availability and accuracy of data and refers to the construction methods of relevant empirical research [57,64]. It calculates the discharge of industrial wastewater, industrial waste gas, and industrial solid waste using the entropy weight method to obtain a comprehensive environmental regulation index.

Local government competition (GOV): Most of the literature uses the ratio of productive expenditure to total regional budget expenditure [65], FDI per capita, FDI per unit of GDP, and the share of FDI in national FDI [66] as proxy variables. However, this paper suggests motives for chasing and surpassing neighboring prefecture-level cities in the whole region. Therefore, referring to the research method of Miu et al. [67], this paper adopts the level of economic catching up as a proxy variable of local government competition.

First, this paper calculates the highest per capita GDP of neighboring cities divided by the highest per capita GDP of decision-making units. Next, it calculates the highest per capita GDP of all the regions and cities divided by the highest per capita GDP of decision-making units. Finally, it multiplies the two to obtain the economic catch-up level.

#### 2.4.3. Control Variables

This paper refers to the existing literature research [20,24] and selects the following control variables: (1) urban population density (DEN), measured by the proportion of the urban population in the area of administrative divisions; (2) the level of informatization (INO), measured by the proportion of regional post and telecommunications business revenue to GDP; (3) infrastructure (INF), measured by the per capita urban road area;

(4) industrialization level (IND), measured by the proportion of secondary industry output value in total production; (5) human capital (HU), measured by the number of college students per 10,000 people; and (6) industrial structure (IS), measured by the proportion of the output value of the tertiary industry to the output value of the secondary industry. The meaning of the variables and a descriptive statistical analysis are shown in Table 2.

**Table 2.** Descriptive statistics.

| Variable | Variable Definitions | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| HQD | High-quality development | 0.44 | 0.07 | 0.27 | 0.67 |
| ER | Environmental regulation | 0.93 | 0.09 | 0.35 | 0.99 |
| GOV | Economic catch-up level | 14.63 | 21.74 | 0.47 | 211.71 |
| DEN | Urban population accounts for administrative division area | 399.63 | 313.34 | 4.70 | 1440.37 |
| INO | Regional post and telecommunications business revenue to GDP | 2.57 | 1.86 | 0.38 | 18.91 |
| INF | Urban road area per capita | 15.93 | 7.86 | 1.37 | 60.07 |
| IND | Secondary industry output value to GDP | 50.87 | 11.87 | 15.60 | 84.88 |
| HU | Number of college students per 10,000 people | 164.48 | 240.91 | 1.67 | 1310.74 |
| IS | Output value of the tertiary industry accounts for the output value of the secondary industry | 1.58 | 1.40 | 0.27 | 21.28 |

## 3. Results

### *3.1. Benchmark Regression*

The estimated results of the benchmark regression are shown in Table 3. Column (1) is the OLS estimation result. The estimated coefficient of environmental regulation is 0.459, which is significant at the 1% statistical level. Columns (2)–(5) control the fixed effects of city and year, and they introduce the control variables one by one. The estimated coefficients of environmental regulation are still significantly positive, and they are significant at the 1% statistical level, indicating that environmental regulation can significantly improve the HQD level of the YRB. The research hypothesis H1 is validated. As shown in column (5) of Table 3, local government competition has a significantly negative impact on HQD, indicating that, in order to catch up with the economic level of the surrounding cities in the region, the policies implemented by the local government will reduce the HQD level of the local city. On the one hand, the "promotion championship" hypothesis holds that local officials tend to focus on the economy and that they neglect the environment for their political performance and promotion opportunities, resulting in the lack of effective protection of local environmental quality [38]. On the other hand, under the development goal of "only GDP", local governments will relax environmental regulations. The region will absorb high-polluting, high-energy-consuming industries in developed regions. Intensified competition benefits GDP growth, but environmental pollution intensifies, and the negative externality of environmental pollution is significant [68]. This competition will also cause ecological damage and reduce the level of HQD. As shown in column (5) of Table 3, the coefficient of the interaction term between environmental regulation and local government competition is −0.020, which is significant at the 1% statistical level. This regression result shows that, with the improvement of local government competition, the role of environmental regulation in promoting HQD is weakened. The research hypothesis H2 is validated.

In addition, regarding the control variables, the level of informatization, the improvement of human capital, and the optimization of the industrial structure have a significantly positive impact on HQD. The increase in urban population density and the proportion of secondary industries have a significant negative impact on the level of HQD. This shows that the HQD of the YRB will be affected not only by the environmental and local government competition but also by other factors.

**Table 3.** Benchmark regression results.

| Variable | (1) OLS | (2) FE | (3) FE | (4) FE | (5) FE |
|---|---|---|---|---|---|
| ER | 0.459 *** | 0.130 *** | 0.130 *** | 0.183 *** | 0.182 *** |
| | (0.027) | (0.008) | (0.008) | (0.016) | (0.016) |
| LnGOV | −0.055 *** | | −0.001 | −0.018 *** | −0.009 * |
| | (0.009) | | (0.001) | (0.005) | (0.005) |
| ER × LnGOV | −0.079 *** | | | −0.022 *** | −0.020 *** |
| | (0.010) | | | (0.006) | (0.005) |
| LnDEN | 0.001 | | | | −0.033 *** |
| | (0.001) | | | | (0.010) |
| LnINO | 0.001 | | | | 0.002 * |
| | (0.002) | | | | (0.001) |
| LnINF | 0.030 *** | | | | −0.001 |
| | (0.002) | | | | (0.002) |
| LnIND | −0.055 *** | | | | −0.036 *** |
| | (0.005) | | | | (0.005) |
| LnHU | 0.017 *** | | | | 0.002 * |
| | (0.001) | | | | (0.001) |
| LnIS | −0.010 *** | | | | 0.004 ** |
| | (0.002) | | | | (0.002) |
| Individual effect | No | Yes | Yes | Yes | Yes |
| Time effect | No | Yes | Yes | Yes | Yes |
| Constant | 0.108 *** | 0.259 *** | 0.261 *** | 0.214 *** | 0.564 *** |
| | (0.033) | (0.007) | (0.008) | (0.014) | (0.058) |
| Observations | 1248 | 1248 | 1248 | 1248 | 1248 |
| R-squared | 0.765 | 0.748 | 0.748 | 0.749 | 0.755 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; numbers in parenthesis are robust standard error.

### 3.2. Threshold Effects Regression

This paper uses the threshold effect bootstrapping method (bootstrap) to test whether there is a threshold value and the number of thresholds in the model (2). The results are shown in Table 4. When the threshold variable is local government competition, the F statistic is 58.07 in the single-threshold effect estimate, which is significant at the 1% level and rejects the assumption of a linear relationship; in the double-threshold effect estimate, the F statistic is 19.95, which is not significant. The result of the significance test shows that there is no double threshold. Therefore, a single threshold is more appropriate.

**Table 4.** Results of threshold conditions test and double threshold estimated value.

| Threshold Variable | Hypothetical Test | Estimated Parameter | F Value | *p* Value |
|---|---|---|---|---|
| LnGOV | Single threshold | 3.037 | 58.07 | 0.000 |
| | Double threshold | 3.367 | 19.95 | 0.032 |

Table 4 shows a threshold value of 3.037 with local government competition as the threshold effect. The regression results in Table 5 show that, when the local government competition level LnGOV $\leq$ 3.037, the relationship between environmental regulation and HQD is significantly positively correlated at the 1% level, with a coefficient of 0.260. When the local government competition level is greater than 3.037 (LnGOV > 3.037), the impact of environmental regulation on HQD is significantly positive. This result still passes the significance test at the 1% level, but the coefficient is reduced to 0.239. The above analysis shows that, with the improvement of the competition level of local governments, the positive impact of environmental regulation on the HQD of the YRB is weakened, which is consistent with the above research conclusions and verifies H3.

**Table 5.** Estimation results and tests of threshold regression mode.

| Variable | Regression Coefficient | Standard Error | *p* Value |
|---|---|---|---|
| ER (LnGOV ≤ 3.037) | 0.260 | 0.012 | 0.000 |
| ER (LnGOV > 3.037) | 0.239 | 0.013 | 0.000 |
| LnDEN | 0.111 | 0.015 | 0.000 |
| LnINO | −0.008 | 0.002 | 0.000 |
| LnINF | 0.035 | 0.003 | 0.000 |
| LnIND | −0.083 | 0.006 | 0.000 |
| LnHU | 0.022 | 0.002 | 0.000 |
| LnIS | −0.016 | 0.003 | 0.000 |
| Constant | −0.273 | 0.086 | 0.002 |

### 3.3. Heterogeneity

According to the above test of the threshold effect, it is confirmed that environmental regulation has a nonlinear relationship with HQD. However, differences in resource endowment, ecological environment, and economic development among different regions of the YRB lead to heterogeneity [69]. This paper further investigates the heterogeneous impact of environmental regulation on the HQD level in the different regions of the YRB. This paper divides the sample into three subsamples: "upstream", "midstream", and "downstream". The results are shown in Table 6.

**Table 6.** Heterogeneity analysis based on different regions.

| Variable | (1) Upstream | (2) Midstream | (3) Downstream |
|---|---|---|---|
| ER | 0.171 *** | 0.136 *** | 0.329 *** |
| | (0.022) | (0.034) | (0.061) |
| LnGOV | −0.016 * | −0.009 | −0.088 *** |
| | (0.008) | (0.009) | (0.023) |
| ER × LnGOV | −0.018 ** | −0.007 | −0.098 *** |
| | (0.008) | (0.010) | (0.025) |
| LnDEN | −0.064 *** | 0.024 | 0.019 |
| | (0.014) | (0.025) | (0.018) |
| LnINO | 0.003 | −0.001 | 0.005 ** |
| | (0.002) | (0.002) | (0.002) |
| LnINF | 0.005 | −0.004 | 0.005 * |
| | (0.003) | (0.003) | (0.003) |
| LnIND | −0.038 *** | −0.046 *** | −0.044 *** |
| | (0.008) | (0.008) | (0.012) |
| LnHU | 0.001 | −0.004 ** | −0.003 |
| | (0.002) | (0.002) | (0.003) |
| LnIS | 0.006 | 0.002 | 0.002 |
| | (0.004) | (0.003) | (0.004) |
| Individual effect | Yes | Yes | Yes |
| Time effect | Yes | Yes | Yes |
| Constant | 0.564 *** | 0.344 ** | 0.190 |
| | (0.072) | (0.143) | (0.116) |
| Observations | 336 | 448 | 464 |
| R-squared | 0.757 | 0.779 | 0.758 |

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; numbers in parenthesis are robust standard error.

As shown in columns (1)–(3) of Table 6, environmental regulation has a significant promoting effect on the HQD level of the upper, middle, and lower regions, respectively, and all of them are significant at the 1% statistical level. By comparing coefficients, environmental regulation has a more significant positive impact on HQD for the lower reaches of the YRB. The lower reaches of the Yellow River are rich in various resources and have a good foundation for development [6]. However, environmental pollution is severe due to the over-exploitation of energy and mineral resources and the development of heavy chemical industries in the middle and upper reaches [70]. Environmental regulation has led to an increase in the cost of pollution reduction for enterprises and a lack of innovation motivation. As a result, it has a weaker impact on HQD. The interaction term of environmental regulation and local government competition in the upper reaches of the YRB is significantly negative at the 5% level, the lower reaches are significantly negative at the 1% level, and the middle reaches are insignificant. The stronger the environmental regulation is, the lower the pollution emissions and the higher the level of HQD. However, as the level of competition between local governments intensifies, the role of environmental regulation in promoting the level of HQD is weaker.

### *3.4. Robustness Test*

#### 3.4.1. Endogenous Processing

To alleviate the possible endogeneity problem in the benchmark model, according to Arellano and Bover [71], this paper uses the lag one period of the HQD index as an instrumental variable to perform a systematic generalized method of moments (GMM). The results are shown in Table 7. The AR(2) value is greater than 0.1, and the value of Hansen's test is greater than 0.1, indicating that the instrumental variable selected by the model is reasonable. After removing the endogeneity, the lag term coefficient of the HQD index is significant at the statistical level of 1%. The HQD level has a strong trend, and the HQD level of the previous period affects the current period; the environment regulation still has a significant positive impact on the HQD level of the YRB at the statistical level of 1%.

**Table 7.** Robustness test results: endogenous processing.

| Variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| L.HQD [1] | 0.863 *** | 0.819 *** | 0.910 *** | 0.778 *** |
| | (0.061) | (0.029) | (0.012) | (0.032) |
| ER | 0.071 *** | 0.053 *** | 0.032 *** | 0.099 *** |
| | (0.018) | (0.011) | (0.004) | (0.028) |
| LnGOV | | −0.001 * | −0.009 *** | −0.026 *** |
| | | (0.000) | (0.001) | (0.009) |
| ER × LnGOV | | | −0.012 *** | −0.026 *** |
| | | | (0.001) | (0.010) |
| LnDEN | | | | −0.002 *** |
| | | | | (0.000) |
| LnINO | | | | 0.002 *** |
| | | | | (0.001) |
| LnINF | | | | 0.003 *** |
| | | | | (0.001) |
| LnIND | | | | −0.025 *** |
| | | | | (0.003) |
| LnHU | | | | 0.004 *** |
| | | | | (0.001) |
| LnIS | | | | −0.000 |
| | | | | (0.002) |
| Constant | −0.013 | 0.002 | 0.009 *** | −0.161 *** |
| | (0.012) | (0.007) | (0.002) | (0.025) |
| Observations | 1092 | 1092 | 1092 | 1092 |
| AR(2) | 0.123 | 0.156 | 0.196 | 0.221 |
| Hansen test | 0.162 | 0.112 | 0.152 | 0.137 |

Notes: [1] The lag period of HQD. * $p < 0.10$, *** $p < 0.01$; numbers in parenthesis are robust standard error.

#### 3.4.2. Substitution Variable

This paper verifies the stability of the benchmark model from two aspects. One aspect is to recalculate the environmental regulation variables. This paper refers to the idea of Chen et al. [72] to calculate the proxy variables of environmental regulation. First, the proportion of the occurrences of environment-related words in the provincial government work report to the total words in the report is selected. Then, the ratio of the total industrial output value of the prefecture-level city is multiplied by the total industrial output value of the province. Lastly, it calculates the proxy variables of environmental regulation of prefecture-level cities. Columns (1) and (2) of Table 8 report the estimated results of the recalculated environmental regulation variables. Environmental regulation has a positive impact on HQD, and it is significant at the 1% statistical level; the interaction term between environmental regulation and local government competition is significantly negative at the 1% statistical level. The second aspect is to recalculate local government competition variables. This paper uses per capita FDI as a measure of local government competition. Columns (3) and (4) of Table 8 report the estimated results of recalculating the local government competition variables. Environmental regulation has a positive impact on HQD, and it is significant at the 1% statistical level. In addition, local government competition still has a significant inhibitory effect on the high-quality growth effect of environmental regulation. The above two methods further confirm that environmental regulation can significantly improve the HQD level of the YRB, and they confirm the robustness of the estimation results of the benchmark model.

**Table 8.** Robustness test results: recalculating environmental regulation and local government competition variables.

| Variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| ER | 0.001 *** | 0.001 *** | 0.130 *** | 0.127 *** |
| | (0.000) | (0.000) | (0.008) | (0.011) |
| LnGOV | −0.003 | −0.010 *** | −0.001 | −0.003 *** |
| | (0.002) | (0.002) | (0.000) | (0.003) |
| ER × LnGOV | | −0.001 *** | | −0.004 *** |
| | | (0.000) | | (0.004) |
| LnDEN | | −0.012 | | −0.037 *** |
| | | (0.011) | | (0.010) |
| LnINO | | 0.002 * | | 0.001 |
| | | (0.001) | | (0.001) |
| LnINF | | −0.000 | | −0.001 |
| | | (0.002) | | (0.002) |
| LnIND | | −0.034 *** | | −0.027 *** |
| | | (0.005) | | (0.004) |
| LnHU | | 0.001 | | 0.002 * |
| | | (0.001) | | (0.001) |
| LnIS | | 0.009 *** | | 0.003 |
| | | (0.002) | | (0.002) |
| Individual effect | Yes | Yes | Yes | Yes |
| Time effect | Yes | Yes | Yes | Yes |
| Constant | 0.370 *** | 0.581 *** | 0.258 *** | 0.578 *** |
| | (0.004) | (0.063) | (0.007) | (0.058) |
| Observations | 1248 | 1248 | 1248 | 1248 |
| R-squared | 0.768 | 0.768 | 0.758 | 0.758 |

Notes: * $p < 0.10$, *** $p < 0.01$; numbers in parenthesis are robust standard error.

## 4. Discussion

Existing research suggests that increasing the intensity of environmental regulation can promote economic growth and improve environmental conditions [21,22]. This paper constructs a comprehensive index of HQD, which is different from the previous single index, and it analyzes the impact of environmental regulation on HQD. In addition, it also analyzes the changes in the impact of environmental regulation on HQD under the condition of the increased competition intensity of local governments.

This paper confirms that the impact of environmental regulation on HQD is positive and significant at the 1% statistical level. The stronger the regional environmental regulation is, the higher the threshold for enterprises to enter. This will force high-pollution enterprises to improve green production processes by adjusting their product structure, environmental protection technology, and other production behaviors. This method will promote the greening and high added value of the production process and, ultimately, achieve the goals of reducing pollution, improving environmental quality, and achieving a win–win situation for the economy and the environment [73]. However, companies with "high pollution, high emissions, and high energy consumption" will move out of areas with high levels of environmental regulation, thereby providing development space for other companies that meet environmental regulation standards. The environmental regulation will promote the optimization of the region's industrial structure to a green and sustainable structure, in order to protect the ecological environment and promote the sustainable development of the local economy, thereby further improving the HQD level of the region [74].

This paper also reveals that the coefficient of the interaction term of environmental regulation and local government competition is negative and significant at the 1% statistical level. In addition, when the local government competition represented by the level of economic catch-up exceeds the threshold value of 3.037, this positive effect of environmental regulation on HQD decreases significantly. On the one hand, local governments pursue short-term interests, tend to attract liquidity such as external investment, and reduce investment in public services such as environmental protection [43]. When local governments unilaterally pursue economic development, they often lower environmental standards, and it is difficult to implement environmental regulatory measures effectively [42]. Local governments implement more relaxed environmental governance methods to attract more foreign investment or investment from enterprises in other regions, which, in turn, leads to investment and tax competition between regions, further leading to environmental pollution deterioration. Therefore, local government competition weakens the role of environmental regulation in promoting HQD.

The main contributions of this paper are as follows: (1) Most of the previous studies focused on the whole country or province and measured the HQD level in a cross-section or a short time. Due to the multi-dimensional attributes of HQD with rich connotations, this paper builds a more comprehensive and longer-term HQD index system for prefecture-level cities. (2) This paper incorporates environmental regulation, local government competition, and HQD into the same analytical framework. It adds their interaction terms to explore the combined effect of environmental regulation and local government competition, a supplement to the existing research. (3) This paper constructs a panel threshold model with local government competition as the threshold variable to explore the possible nonlinear relationship between environmental regulation and HQD. (4) This paper uses the generalized method of moments (GMM) to solve the endogeneity problem. Therefore, the reliability of the empirical results is verified. (5) From the perspective of regional heterogeneity, the HQD effects of environmental regulation in the Yellow River basin's upper, middle, and lower reaches are tested to explore the path for improving the HQD of the YRB.

This paper has the following limitations, which can be further improved in the future: The research area of this paper is the YRB; future research should be extended to other river basins, and a comparative analysis should be carried out. In addition, the HQD index system does not consider the issue of carbon emissions and the efficiency of hydropower utilization. In the future, it is necessary to further improve the connotation and evaluation index system of HQD. Lastly, the impact of environmental regulation on HQD does not consider the spatial effect of environmental regulation. Therefore, in future research, it is necessary to further analyze the impact of environmental regulation on HQD from a spatial perspective.

## 5. Conclusions

This paper analyzes the impact of environmental regulation and local government competition on the HQD of the YRB. The results show that environmental regulation has a significant positive impact on HQD. The competition between local governments has an inhibitory effect on the improvement of HQD. Otherwise, with the intensification of competition among local governments, the role of environmental regulation in promoting

HQD weakens. Between the development of the economy and the protection of the environment, the local government chooses the speed of economic development, but it ignores the quality of economic development and destroys the ecological environment. Under the single-threshold model, the impact of environmental regulation on HQD has a significant nonlinear positive effect on the improvement of local government competition. Still, when the local government competition exceeds the threshold of 3.037, this positive effect decreases significantly. Regarding the heterogeneity analysis, environmental regulation has a greater effect on the lower reaches of the YRB.

Therefore, further strengthening the environmental regulation of the whole basin is necessary. By promulgating the regulations and policies related to pollution prevention and control, environmental supervision and other means of restraining the pollutant discharge behavior of economic entities are strengthened. The government should use the market mechanism in order to actively motivate enterprises to update methods to reduce pollution emissions. The efficiency of regulation should be improved through voluntary regulatory means, such as environmental information disclosure and participation systems; pollution should be reduced; and the goal of harmonious development between economy and nature should be sought. Moreover, it is necessary to regulate the competition of local governments. The government should optimize the promotion assessment system with economic growth as the single goal or increase the weight of environmental indicators in the assessment system to promote the YRB in order to achieve a high-quality economic–ecological–environmental development model. Lastly, it is necessary to implement different environmental regulation methods with different intensities according to the regional heterogeneity of the upper, middle, and lower reaches. The upstream should appropriately control the intensity of environmental regulation, and incentive-type and guiding-type regulatory policies should be chosen, such as ecological compensation, to provide sufficient cost compensation and income guarantee for ecological protection. The downstream should increase the intensity of environmental regulation, promote the innovation compensation effect, and transform industrial upgrading and the green development model.

**Author Contributions:** Author Contributions: Conceptualization, Y.Z.; methodology, Y.W.; software, Y.W.; validation, Y.W.; formal analysis, Y.W.; investigation, Y.Z.; resources, Y.Z.; data curation, Y.Z. and Y.W.; writing—original draft preparation, Y.W.; writing—review and editing, Y.J.; visualization, Y.J.; supervision, Y.Z.; project administration, Y.Z.; funding acquisition, Y.Z. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the key project of the National Social Science Foundation of China (No. 21AZD042) and the special project for cultivating leading talents in philosophy and social sciences in Zhejiang Province (No. 21YJRC06ZD, 21YJRC06-2YB).

**Data Availability Statement:** Publicly available datasets were analyzed in this paper. This data can be found here: https://data.cnki.net/Yearbook/Single/N2021050059 (accessed on 1 May 2022).

**Acknowledgments:** The authors are grateful to the editors and the anonymous reviewers for their insightful comments and helpful suggestions.

**Conflicts of Interest:** The authors declare no conflict of interest.

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