Digital Economy and Green Development in the Yellow River Basin

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Abstract. The development of digital economy has brought profound impact on the green development and environmental protection of the Yellow River basin in China. Based on the data of 96 cities in the Yellow River Basin from 2011 to 2019, this paper calculates the urban digital economy and green development indicators in the Yellow River Basin. Applying fixed effect models, regulatory effects, and other methods to examining the impact mechanism of the digital economy on the ecological environment protection in the Yellow River Basin the authors found that the development of digital economy would significantly improve the overall green development of the Yellow River basin. Based on the heterogeneity analysis the authors also found that the impact of digital economy on the green development of the middle and upper reaches of the Yellow River was even more significant. The regulatory effect indicates that the increase in the output value of the secondary industry and energy consumption will reduce the effect of the digital economy on green development. Accordingly, we could propose applicable policies for improving digital infrastructure, developing the digital economy in accordance with local conditions, adjusting industrial structure and reducing energy consumption.

Keywords: digital economy; Yellow River Basin; Green development

1 Introduction

In October 2021, the State Council proposed to strengthen the environmental pollution control system in the Yellow River Basin, making protecting the ecological environment of the Yellow River Basin a national policy. However, since the reform and opening up, the industrialization process in the nine provinces and regions of the Yellow River Basin has accelerated, and the attention to environmental protection has not been enough, resulting in serious damage to the environment in the Yellow River Basin [1]. The fragile ecological environment restricts the high-quality development of the Yellow River Basin, so how to promote ecological protection in the Yellow River Basin has become a key development focus for provinces along the Yellow River.

Traditional theory believes that the effectiveness of green development is influenced by multiple factors, such as environmental regulation and industrial structure. But with

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the development of the times, the development of the digital economy has injected new vitality into the green development of the Yellow River Basin. The digital economy is the product of the digital era, and with the development of digital technologies such as the Internet of Things, Big data and artificial intelligence, it has become a new "engine" to promote economic development [2]. As one of the important influencing factors of economic development, the digital economy plays an important role in promoting ecological protection and high-quality development in the Yellow River Basin. At present, various cities in the Yellow River Basin are accelerating the adjustment of industrial structure, improving production efficiency, and promoting innovative development to promote ecological protection and reduce pollutant emissions. In this context, the development of the digital economy provides new ideas for solving ecological protection problems in the Yellow River Basin and promoting green development in the Yellow River Basin.

Based on the above views, this paper uses the Panel data of 96 cities in the Yellow River basin from 2011 to 2019 to analyze the relationship between urban digital economy and green development in the Yellow River basin, and uses the moderating effect to conduct mechanism research.

2 Research Model and Data Explanation

2.1 Research model

In order to verify the impact of digital economy on the green development of the Yellow River Basin, based on the above theoretical assumptions, this paper constructs the following econometric model:

$$EP_{it} = \beta_0 + \beta_1 lndig_{it} + \beta_c X_{it} + u_i + v_t + \varepsilon_{it} \tag{1}$$

The dependent variable EP_{it} represents the Yellow River Basin Green Development Index, the core explanatory variable dig represents the level of urban digital economy development, X_{it} represents a series of control variables, including urban economic development level, greening situation, consumption level, education level, and fiscal expenditure, etc., i represents the city, t represents the year, and u_i is the fixed effect of the city, v_t is a fixed time effect ε_{it} indicates random error term.

The impact of the digital economy on green development will be influenced by some factors, such as urban industrial structure and energy consumption. Therefore, this paper constructs the following regulatory effect model：

$$EP_{it} = \beta_0 + \beta_1 lndig_{it} + \beta_2 M_{it} + \beta_3 lndig_{it} \times M_{it} + \beta_c X_{it} + u_i + v_t + \varepsilon_{it} \tag{2}$$

Where M represents the moderating variable β_3 is the interaction coefficient, representing the impact of the moderating variable on the relationship between digital economy development and urban green development.

2.2 Variable Selection

2.2.1 Dependent variable

Green development (*EP*). This paper constructs a green development indicator system consisting of 9 indicators from two dimensions: environmental pollution and environmental protection (Table 1) [3].

Table 1. Evaluation Index System for Urban Green Development in the Yellow River Basin

Primary indicators	Secondary indicators	Indicator attribute
Environmental pollution	Industrial wastewater discharge	Negative
	Industrial sulfur dioxide emissions	Negative
	Industrial smoke (powder) dust emissions	Negative
Environmental protection	Comprehensive utilization rate of general industrial solid waste	Positive
	Centralized treatment rate of sewage treatment plant	Positive
	Harmless treatment rate of household waste	Positive
	Per capita water supply	Positive
	Green coverage rate	Positive
	Per capita park area	Positive

Data source: made by the author

2.2.2 Core explanatory variables

This paper selects the Internet penetration rate of Prefecture-level city, the output of Internet related industries, the number of Internet related industrial personnel, the penetration rate of mobile phones and digital financial inclusion index data, and uses the method of principal component analysis to build a comprehensive indicator of the digital economy [4]. The Digital Inclusive Finance Index draws inspiration from Guo et al. (2020) [5].

2.2.3 Moderator variables

This paper selects the logarithms of Secondary sector of the economy output value and industrial power consumption to represent the development of Secondary sector of the economy and energy consumption of Prefecture-level city respectively.

2.2.4 Control variables

This paper selects financial development level, resident income level, economic development level, fiscal expenditure, and resident consumption level as control variables.

3 Empirical results

3.1 Basic regression results and Robustness tests

Table 2 reports the impact of digital economy development on green development in the Yellow River Basin based on equation (1). The coefficient of digital economy development in model (1) is positive and significant at the 1% level, indicating that the development of digital economy in cities in the Yellow River Basin can promote urban green development. From the perspective of controlling variables, the improvement of factors such as urban financial level, resident income level, economic development level, fiscal expenditure level, and resident consumption level in the Yellow River Basin has a significant impact on the level of green development.

This article adopts the methods of subsample regression and tail regression for robustness testing. It can be seen from Table 1 model (2) and model (3) that the coefficient of digital economy is significantly positive, which can confirm that the regression results above are robust. In order to alleviate the endogenous problem, this paper chooses the lagging period of digital economy as a tool variable to test again. As shown in Table 1 model (4), the coefficients of the digital economy are significantly positive at the level of 1% significance, which confirms the robustness of the previous regression results.

Table 2. Basic regression results and robustness tests

	model（1） *EP*	model（2） *EP*	model（3） *EP*	model（4） *EP*
lndige	0.0324**	0.0318**	0.0316**	0.0813***
	(0.0134)	(0.0150)	(0.0128)	(0.0274)
finance	0.0061***	0.0069***	0.0145***	0.0052***
	(0.0020)	(0.0023)	(0.0051)	(0.0019)
lnrevenue	0.1630***	0.1765***	0.1391***	0.1442***
	(0.0373)	(0.0391)	(0.0347)	(0.0232)
lnGDPP	0.0444**	0.0507**	0.0437**	0.0292**
	(0.0195)	(0.0199)	(0.0208)	(0.0135)
fiscal	0.1132*	0.1122*	0.1068	0.0493
	(0.0652)	(0.0636)	(0.0659)	(0.0390)
lnconsume	0.0177*	0.0183**	0.0181*	0.0220*
	(0.0090)	(0.0090)	(0.0105)	(0.0112)
cons	-1.7741***	-1.9807***	-1.5416***	-1.5482***
	(0.4584)	(0.4767)	(0.4425)	(0.3103)
Urban fixed	YES	YES	YES	YES

Year fixed	YES	YES	YES	YES
N	864	774	864	768
R^2	0.353	0.379	0.342	0.885

Note: The parentheses indicate standard error, while *, **, and *** respectively indicate significance at the 10%, 5%, and 1% significance levels, the same below.

Data source: Stata16.0 calculation results

3.2 Moderating effect

In order to further verify the relationship between digital economy and green development in the Yellow River basin, this paper selects secondary industry output value and energy consumption as moderator variables, and inspects the moderating effect between digital economy and green development according to the equation (2). The results are as in Table 3.

According to the regression results of Table 3 model (5), the digital economy coefficient is positive, but the interaction coefficient between the digital economy and the industrial structure is negative. The development of secondary industry will bring about environmental pollution, and the increase of the area of industrial parks will lead to the reduction of urban greening area. However, industrial development is an essential factor for economic development in the Yellow River basin area. Therefore, the effect of digital economy on urban green development in the Yellow River basin is inhibited by the development of secondary industry.

The regression results of Table 3 model (6) show that the digital economy coefficient is positive, while the interaction coefficient between the digital economy and energy consumption is negative. This result verifies that energy consumption plays a negative regulatory role between the digital economy and urban green development. The increasing consumption of energy is based on the continuous production of energy plants. However, at present, the supply of clean energy in our country is small, and a large amount of energy supply needs to be obtained by traditional processing of heavy industrial raw materials. As a result, a large number of pollutants will be discharged during the production process, which weakens the promotion of digital economic development to urban green development.

Table 3. Moderating effect

	Model（5） EP	Model（6） EP
$lndige$	0.1752*** (0.0563)	0.1812** (0.0885)
$lnsi$	-0.0329 (0.0258)	
$lndige * lnsi$	-0.0227*** (0.0083)	
$lnenergy$		0.0135** (0.0062)

$lndige * lnenergy$		-0.0117* (0.0066)
Control variables	YES	YES
N	864	864
R^2	0.385	0.367

Data source: Stata16.0 calculation results

4 Conclusion

This paper analyzes the relationship between digital economy and green development in the Yellow River basin by constructing green development indicators and digital economy indicators, using the urban panel data of the Yellow River basin, and using empirical methods. The main conclusions are as follows: Firstly, the digital economy has effectively promoted the green development of cities in the Yellow River Basin, and this conclusion remains valid after robustness testing. Secondly, due to the impact of urban industrial structure and energy consumption, the promotion effect of digital economy on green development of cities in the Yellow River Basin will decrease.

Based on the above research conclusions, the following insights are drawn:

Firstly, promote the development of digital economy in river basin cities and improve the construction of digital infrastructure. Most cities in the Yellow River Basin are still in the initial stage of digital construction, and it is necessary to accelerate the construction of digital infrastructure to lay the foundation for the rapid development of the digital economy and the green transformation of the economy.

Secondly, cities in the Yellow River Basin need to adjust their industrial structure, promote the integration of digital economy and industry development, promote the digital transformation of industrial enterprises, reduce enterprise energy consumption, and make the digital economy more effective.

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