Research on the Impact and Mechanism of Ningxia's Digital Economy Development on Environmental Pollution

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Abstract. With the digital economy's recent rapid expansion, it has steadily merged into a variety of areas, including business production, government governance, and resident life, and social and economic development has seen significant changes. In this context, based on the data of five cities in Ningxia from 2011 to 2021, this study uses the hybrid OLS model and different dimensions of digital economy to empirically test the impact of Ningxia's digital economy development on urban environmental pollution and its internal mechanism. The main conclusions as follows: First, the digital economy in Ningxia has significantly reduced the emission of urban environmental pollutants. At the same time, the conclusion is still valid after the robustness test using the method of explanatory variables lagging one period; second, the analysis is carried out in different dimensions of the digital economy It was found that Ningxia's digital economy coverage, depth of digital economy use, and degree of digitization of the digital economy all have a negative inhibitory effect on urban environmental pollution, and it is significant at the 1% level, indicating that different dimensions of the digital economy contribute to Reduce urban environmental pollution emissions. The research conclusions provide a reliable empirical basis for Ningxia's digital economy to help environmental pollution control, and at the same time provide relevant suggestions for the development of the digital economy and the decision-making of pollution reduction and emission reduction of the digital economy.

Keywords: Ningxia Province, Digital Economy Development, Environmental Pollution, Hybrid OLS

1 Introduction

Economic development is inseparable from the consumption of resources. In 1978, China implemented the reform and opening policy to further promote the rapid economic development. At the same time, the extensive development model consumed a lot of resources, and the pollutant discharge increased rapidly. China's environmental pollution problems urgently need to be addressed. In recent years,

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China has invested heavily in green development and environmental governance. China specifically suggested the targets of "carbon peak" in 2030 and "carbon neutrality" in 2060, particularly in September 2020. The "double carbon" objective supports a low-carbon, eco-friendly, and sustainable way of living. It can quicken the pace of carbon emission reduction, which is helpful for directing green technology innovation and enhancing China's industry's and economy's competitiveness on the international stage. In the process of achieving carbon neutrality and carbon peaking, we must pay attention to the development of new technologies with strategic significance, such as artificial intelligence, information technology and digital technology. By 2022, China's digital economy will be worth 50.2 trillion yuan, ranking second globally and making up 41.5% of GDP. The digital economy has considerably aided in the high-quality expansion of cities and has grown to be a key driver of consistent economic growth and transformation[1, 2].

The growth of digital financial inclusion is integral to the development of China's digital economy. Between 2011 and 2018, China's digital financial inclusion made rapid advancements. From 33.6 in 2011 to 2018, the median value of the digital financial inclusion index increased for each province. 294.3, representing a 36.4% average yearly growth. The emergence of digital inclusive finance has aided in the healthy growth of the digital economy and served as a key engine of expansion for encouraging high-quality economic development. High-quality economic growth can lead to energy conservation, reduced emissions, and green development by further optimizing the industrial structure and allocating resources judiciously.

So, has the digital economy reduced pollution while propelling China's economy to high-quality development? Do the development of the digital economy, its coverage, the depth of usage of the digital economy, and the degree of digitization of the digital economy have distinct effects on pollution? If the above conclusions can be confirmed, what is the mechanism behind it? For the above problems, this study takes Ningxia as the research object to discuss. Ningxia actively grasps major strategic opportunities such as the national "Belt and Road" construction and the development of the western region in the new era, and accelerates the construction of a pilot zone for ecological protection and high-quality development in the Yellow River Basin and an inland open economic experiment zone. By building a national hub node of China's integrated computing power network, it has formed a first-in-first-out policy advantage and capability advantage, providing a strong support for international cooperation in serving the "Belt and Road" digital economy.

2 Literature Review and Hypothesis Development

2.1 Digital economy development and environmental pollution

The essence of green development is a complete shift in production methods, lifestyles, thinking patterns, and values. It challenges traditional development thinking, development principles, and development approaches. It is a change in the rules of nature and the general laws of long-term economic and social growth. It is an unavoidable decision to modify the economic structure, change the development mode, and achieve long-term development. The growth of the digital economy has aided green development by providing a significant assurance for increasing high-quality economic development and environmental conservation.

The digital economy, according to extant literature, is a new paradigm of high-quality development that can support green development and high-quality economic development by driving economic growth and developing technology[3]. The key to green development is the cleanliness of the industrial structure. The development of the digital economy can promote the upgrading of the industrial structure, continuously promote enterprises to upgrade technology, optimize management models, improve product quality, optimize enterprise structure and improve the industrial chain, thereby reducing urban pollutant emissions and effectively Improve energy resource utilization efficiency[4]. The green development of enterprises can rely on digital economy development technology, realize the integration of various information through digital economy technology, continuously improve energy utilization efficiency and reduce waste, and high production efficiency can promote green development of enterprises[2]. Secondly, the digital economy can improve the level of green technology, which can reduce consumption, reduce pollution and improve the ecological environment[5]. As far as its mechanism is concerned, the digital economy can continuously reduce carbon emissions and reduce environmental pollution by improving resource utilization efficiency, optimizing industrial structure and improving the level of green technology[6]. In addition, the digital economy can also enhance the government's ability to regulate the environment. The government can use digital economic means such as big data, remote sensing technology or cloud computing to strengthen the dynamic monitoring of environmental pollution, and use digital economic means to effectively collect relevant environmental monitoring data to provide reliable support for environmental governance[7]. In summary, this study proposes the following hypotheses:

Hypothesis 1: The development of the digital economy has a negative inhibitory effect on environmental pollution

2.2 Coverage of the digital economy and environmental pollution

The coverage of the digital economy refers to the popularity of the digital economy in different regions, industries and fields. The digital economy has high innovation, strong penetration, and wide coverage, which can significantly promote economic growth and promote industrial digitization. Due to the different levels of GDP development and technological development in different regions, the coverage of the digital economy is also different. Compared with the eastern region and the central and western regions, the eastern region has a higher degree of digitalization, but the digital economy development speed of the central and western regions is faster than that of the eastern region[8]. In recent years, with the development of the Internet, artificial intelligence, and cloud computing, socialized large-scale production has been promoted to achieve networked collaboration. The types, quantities, and combinations of factors of production will produce "chemical reactions" on the network, so that technological innovation can affect the Productivity gains have a "power effect". Environmental pollution has been further improved through technological innovation[9]. In summary, this study proposes the following hypotheses:

Hypothesis 2: The coverage of the digital economy has a negative inhibitory effect on environmental pollution

2.3 The depth of digital economy use and environmental pollution

The depth of use of the digital economy refers to the degree of integration of digital technology and the real economy, and is also an important indicator for measuring the development level of the digital economy. The deep integration of China's digital economy and the real economy has greatly promoted the upgrading and transformation of the domestic real economy's industrial structure. The organic integration of the digital economy and the real economy will help optimize the allocation of production factors and improve the efficiency of resource use[10]. The development and growth of the digital economy is behind the rapid development and widespread use of modern information technology. It is precisely because of the objective existence of digital means such as cloud computing, the Internet of Things, and big data that more economic entities can participate in the process of socialized mass production. Among them, thus objectively breaking the information barriers and economic isolation caused by various factors in the traditional economic form. The use of digital technology can accurately allocate enterprise resources, reduce the marginal cost of enterprise production, and then improve the efficiency of enterprise production and operation. Moreover, digital technology can improve the level of collaborative application of input from various departments, promote the optimization and upgrading of industrial structure, and achieve high-quality industrial development[11]. The technique of integration of the digital and real economies can efficiently reduce pollution emissions into the environment. In summary, the following assumptions are proposed in this study:

Hypothesis 3: The depth of digital economy use has a negative inhibitory effect on environmental pollution

2.4 Digitization degree of digital economy and environmental pollution

The degree of digitization of the digital economy refers to the degree of application and penetration of digital technology in economic activities, which is typically assessed by the digital economy scale to GDP ratio. According to the "Digital China Development Report (2020)," the added value of China's digital economy's core industries accounted for 7.8% of GDP in 2020, ranking second in the world. The digital economy can penetrate the industrial structure or energy consumption structure, optimize the layout of industrial enterprises, promote the reform of enterprise production methods, and realize the sustainable development of enterprises[12], further reduce the excessive consumption of energy resources by enterprises, save costs, reduce resource consumption, and reduce pollutant emissions[13]. At the same time, with the effective use of cloud computing, Internet of

Things, artificial intelligence and other digital technologies in enterprise production activities, the structure of enterprise resource consumption has been further improved, and enterprise upgrading and transformation have been promoted[14], thereby greatly reducing environmental pollution. In summary, this study proposes the following research hypotheses:

Hypothesis 4: The degree of digitization of the digital economy has a negative inhibitory effect on environmental pollution

3 Data and Research Methodology

3.1 Model structure

In order to determine whether the growth of the digital economy has decreased Ningxia's urban environmental pollutant emissions, this study constructs the following mixed OLS panel data model:

$$lnY=\alpha_0+\alpha_1X_{it}+\alpha_2PEE_{it}+\alpha_3GCRB_{it}+\alpha_4AVS_{it}+\alpha_5PD_{it}+\alpha_6lnGDP_{it}+\alpha_7lnAICP_{it}+u_{it} \quad (1)$$

In the formula; i represents the city; t represents the year; Y represents the explained variable, which are industrial wastewater discharge (lnIWD), industrial sulfur dioxide emission (lnISDE), and industrial nitrogen oxide emission (lnINE); X represents the core explanatory variables, lnIA represents the general index of digital economy inclusive finance, lnCB represents the coverage of digital economy, lnUD represents the depth of digital economy use; the control variable PEE represents education expenditure, GCRB represents the green coverage of built-up areas, and AVS is the second Industrial added value accounts for the proportion of GDP, PD represents population density, lnGDP represents regional gross product, lnAICP represents the investment amount of industrial pollution control construction projects completed this year; u represents random error.

3.2 Variable definition

Variables to be explained. In the study of environmental pollution, according to the availability of data, this study selects industrial wastewater discharge (IWD), industrial sulfur dioxide emissions (ISDE)[15], and industrial nitrogen oxide emissions (ISDE).

Explanatory variables. The digital economy index mainly uses the digital economy general index of the Peking University Digital Inclusive Finance Index to measure the development level of the city's digital economy. At the same time, the digital economy is measured from three perspectives: the coverage of the digital economy, the depth of use, and the degree of digitization. different dimensions of the economy[16-18].

Control variables. The proportion of education expenditure (PEE) adopts the ratio of education expenditure to local fiscal expenditure, the green coverage rate of built-up areas (PEE), the added value of the secondary industry accounts for the proportion of GDP (GCRS), and the population density (PD) adopts population The ratio of the total amount to the area of the region, the gross regional product (GDP) and the investment amount of industrial pollution control construction projects completed this year (AICP). Table 1 below shows the descriptive statistics.

Table 1. Descriptive Statistics.

Category	Variable	Obs	Mean	Std. Dev.	Min	Max
Explained	lnIWD	55	7.175	1.294	3.871	9.313
Variable	lnISDE	55	10.051	1.02	7.62	11.569
	lnINE	55	9.952	1.125	7.34	11.533
Key	IA	55	168.499	69.414	17.02	298.48
Explanatory	CB	55	169.144	74.035	13.83	324.69
Variable	UD	55	144.83	64.758	4.29	253.38
	DL	55	209.386	77.189	7.09	293.94
Control	PEE	55	14.265	2.113	9.575	18.249
Variable	GCRB	55	39.195	6.939	21.56	57.71
	AVS	55	47.472	13.763	19.39	64.98
	PD	55	129.158	70.478	60.832	319.335
	lnGDP	55	15.406	0.691	14.106	16.935
	lnAICP	55	8.987	2.25	0	11.436

3.3 Sample and data description

This study selects 55 samples from the observations of five prefecture-level cities in Ningxia from 2011 to 2021 as the empirical research. The emission data of various pollutants in cities and the data of control variables come from "China City Statistical Year (2012-2022)", "China Regional Statistics (2012-2022)", "Ningxia Statistical Yearbook (2012-2022)". The "Digital Inclusive Finance Index System and Index Compilation" produced by the Internet Finance Research Center of Peking University serves as the source for the digital economy index[17], while industrial wastewater discharge (IWD), industrial sulfur dioxide emissions (ISDE), Industrial nitrogen oxide emissions (INE) are logarithmically processed to obtain lnIWD, lnISDE, lnINE, and the gross regional product (GDP), industrial pollution control construction project investment amount (AICP) is logarithmically processed to obtain lnAICP.

4 Results and Analysis

4.1 Basic regression

Table 2. Basic Regression.

VARIABLES	(1) lnIWD	(2) lnISDE	(3) lnINE
IA	-0.00933***	-0.00476***	-0.00731***
	(-4.176)	(-3.662)	(-5.389)
PEE	-0.0741	-0.0196	0.00191
	(-1.034)	(-0.470)	(0.0440)
GCRB	-0.0357**	-0.0166*	-0.0156
	(-2.155)	(-1.728)	(-1.553)
AVS	0.0325***	0.0593***	0.0593***
	(3.697)	(11.62)	(11.11)
PD	-0.00521*	0.00622***	0.00178
	(-1.857)	(3.819)	(1.046)
lnGDP	1.842***	-0.453*	0.477*
	(4.044)	(-1.710)	(1.724)
lnAICP	-0.110**	0.0570**	-0.0186
	(-2.373)	(2.108)	(-0.657)
Constant	-17.05**	14.62***	1.546
	(-2.430)	(3.586)	(0.363)
R2	0.7915	0.8866	0.8985
Observations	55	55	55
Number of id	5	5	5

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

According to the analysis in Table 2. When analyzing the variable IA, it was found that for every 1% increase in IA, lnIWD, lnISDE, and lnINE decreased by 0.00933%, 0.00476%, and 0.00731%, respectively, and passed the 1% significance test. Industrial wastewater discharge, industrial sulfur dioxide discharge, and industrial nitrogen oxide discharge have a negative inhibitory effect. The reasons are: the development of the digital economy prompts enterprises to adopt more advanced production technologies and management methods, which may lead to industrial wastewater, sulfur dioxide Emissions such as nitrogen oxides and nitrogen oxides are reduced during the production process. New digital technologies and automation systems can optimize production processes, reduce waste of resources, and reduce emissions; at the same time, the development of the digital economy is usually accompanied by more efficient use of resources. Enterprises can identify resource waste and excessive emissions through digital monitoring and data analysis, and take measures to improve production processes and reduce emissions. This helps reduce emissions of waste water, sulfur dioxide and nitrogen oxides.

When analyzing the variable GCRB, it is found that for every 1% increase in GCRB, lnIWD and lnISDE will decrease by 0.0357% and 0.0593%, respectively, and pass the significance test of 5% and 10%, respectively, indicating that the green coverage rate of Ningxia's built-up area has a significant impact on Industrial wastewater discharge and industrial sulfur dioxide discharge have a negative inhibitory effect. The reason is that green space and vegetation can maintain ecological balance and promote the stability of the ecosystem. Ecological balance helps to reduce the accumulation of pollutants in the environment, thereby reducing the impact of industrial emissions on the environment; at the same time, the construction of urban greening and green infrastructure, such as parks, green belts and wetlands, helps to provide places for people to relax and reduce Urban pressure to improve the quality of life of residents. This can also reduce industrial emissions indirectly, because the improvement of environmental quality will prompt the government and enterprises to adopt more environmental protection measures.

When analyzing the variable AVS, it was found that for every 1% increase in AVS, lnIWD, lnISDE, and lnINE increased by 0.0325%, 0.0325%, and 0.0593%, respectively, and passed the 1% significance test, indicating that the added value of the secondary industry in Ningxia The proportion of GDP has a negative inhibitory effect on industrial wastewater discharge, industrial sulfur dioxide discharge, and industrial nitrogen oxide discharge. production activities, which lead to an increase in the scale of industrial production. Large-scale production is usually accompanied by more energy consumption and use of raw materials, resulting in more waste water and emissions; at the same time, the increase in the added value of the secondary industry may indicate more energy demand, especially coal, Fossil fuels such as oil and natural gas. The combustion of these energy sources will release a large amount of air pollutants such as sulfur dioxide and nitrogen oxides, thereby increasing the emission of these pollutants.

When analyzing the variable PD, it is found that for every 1% increase in PD, lnIWD decreases by 0.00521% and passes the 10% significance test, and lnISDE increases by 0.00622% and passes the 1% significance test; Population density has an inhibitory effect on the discharge of industrial wastewater, but has a positive effect on the discharge of sulfur dioxide. The reason for this is that compared with some developed coastal areas, Ningxia has a lower level of industrialization and a relatively small industrial scale. Relatively low population density means relatively few industrial enterprises and production activities, resulting in less industrial wastewater discharge. In addition, lower population density may also lead to lower water consumption, further reducing industrial wastewater discharge. Relatively small population and industrial enterprises can make environmental regulation more centralized and effective, reducing the possibility of environmental violations and wastewater discharge. However, Ningxia is an area rich in energy resources, mainly coal and natural gas. Lower population density means that per capita energy consumption can be higher, and higher energy consumption is usually accompanied by more energy burning, which leads to the emission of pollutants such as sulfur dioxide. Especially in the absence of advanced environmental protection technology, energy combustion often produces a large amount of sulfur dioxide emissions. In addition, Ningxia's geographical conditions and climate may also have an impact on the diffusion and dilution of atmospheric pollutants, making it easier for emitted sulfur dioxide to accumulate in the air.

When analyzing the variable lnGDP, it is found that for every 1% increase in lnGDP, lnIWD increases by 1.842%, lnISDE decreases by 0.453%, and lnINE increases by 0.477%, and they are significant at the levels of 1%, 10%, and 10%, respectively. It shows that Ningxia the regional development level of Ningxia has a positive effect on the discharge of industrial wastewater, a negative inhibitory effect on the discharge of sulfur dioxide, and a positive effect on the discharge of industrial nitrogen oxides. The reason is that the regional development of Ningxia Increased levels may be accompanied by the development of industry and manufacturing, which typically generate large volumes of wastewater. As the economy grows, industrial production and population increase, the demand for water resources will also increase, which may lead to more industrial wastewater discharge. In addition, if environmental protection measures are insufficient or enforcement is lax, industrial wastewater treatment may be limited, leading to increased discharge. However, Ningxia's level of regional development has increased, often accompanied by increased concerns about environmental quality. The government and society may pay more attention to environmental protection issues, strengthen regulatory measures, and promote enterprises to adopt cleaner and low-emission production technologies. This may cause industrial enterprises to pay more attention to reducing the emission of pollutants such as sulfur dioxide in the production process, so that the emission of sulfur dioxide will be reduced. However, similar to industrial wastewater discharge, with economic development and industrial growth, activities such as industrial production and transportation may generate large amounts of nitrogen oxide emissions. Especially in some developing regions, environmental protection measures may not sufficiently keep pace with economic growth, leading to an increase in nitrogen oxide emissions.

When analyzing the variable lnAICP, it is found that for every 1% increase in lnAICP, lnIWD decreases by 0.110%, and lnISDE increases by 0.0570%, which is significant at the level of 5%. It shows that the increase in investment in industrial pollution control in Ningxia has a significant impact on industrial wastewater discharge It has a negative inhibitory effect on industrial sulfur dioxide emissions, and a positive promotion effect on industrial sulfur dioxide emissions; the reason for this is that increasing investment in pollution control usually means adopting more advanced pollution control technologies and facilities. These technologies and facilities can treat wastewater more effectively and reduce the discharge of pollutants. This technological improvement and facility upgrade will directly lead to a reduction in industrial wastewater discharge. However, different industrial production processes will affect the emission of SO2. Some industrial processes may require extensive combustion processes, resulting in high levels of sulfur dioxide. Increased investment in these industrial sectors could lead to increased SO2 emissions.

4.2 Analysis of different dimensions of the digital economy

Table 3. Analysis of Different Dimensions of The Digital Economy.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Coverage breadth of the digital economy			Usage depth of the digital economy			Digitization level of the digital economy		
Variables	lnIWD	lnISDE	lnINE	lnIWD	lnISDE	lnINE	lnIWD	lnISDE	lnINE
CB	-0.0101***	-0.00469***	-0.00672***						
	(-4.386)	(-3.380)	(-4.413)						
UD				-0.00852***	-0.00449***	-0.00730***			
				(-4.198)	(-3.848)	(-6.338)			
DL							-0.00410**	-0.00267***	-0.00439***
							(-2.303)	(-2.716)	(-4.150)
PEE	-0.0423	-0.0119	0.00526	-0.115*	-0.0387	-0.0226	-0.156**	-0.0525	-0.0442
	(-0.574)	(-0.269)	(0.108)	(-1.715)	(-1.001)	(-0.593)	(-2.095)	(-1.275)	(-0.995)
GCRB	-0.0322*	-0.0156	-0.0147	-0.0347**	-0.0159*	-0.0139	-0.0473***	-0.0226**	-0.0247**
	(-1.954)	(-1.579)	(-1.357)	(-2.096)	(-1.669)	(-1.479)	(-2.614)	(-2.257)	(-2.293)
AVS	0.0303***	0.0593***	0.0603***	0.0358***	0.0607***	0.0606***	0.0433***	0.0635***	0.0649***
	(3.415)	(11.17)	(10.34)	(4.293)	(12.65)	(12.79)	(4.752)	(12.61)	(11.96)
PD	-0.00535*	0.00642***	0.00235	-0.00375	0.00690***	0.00262*	-0.00344	0.00660***	0.00210
	(-1.939)	(3.883)	(1.293)	(-1.413)	(4.516)	(1.743)	(-1.078)	(3.755)	(1.106)
lnGDP	2.061***	-0.417	0.456	1.487***	-0.616***	0.274	1.144**	-0.713***	0.125
	(4.312)	(-1.456)	(1.449)	(3.742)	(-2.693)	(1.214)	(2.506)	(-2.830)	(0.461)
lnAICP	-0.112**	0.0550**	-0.0229	-0.114**	0.0557**	-0.0194	-0.120**	0.0548*	-0.0207
	(-2.444)	(2.002)	(-0.761)	(-2.456)	(2.088)	(-0.738)	(-2.318)	(1.918)	(-0.672)
Cons	-20.74	13.91*	1.608	-11.68	17.09*	4.619	-6.041	18.87*	7.374*

tant	***	**		*	**			**	
	(-2.799)	(3.133)	(0.330)	(-1.897)	(4.822)	(1.321)	(-0.871)	(4.931)	(1.788)
R2	0.7972	0.8828	0.8839	0.7921	0.8892	0.9115	0.7431	0.8740	0.8798
N	55	55	55	55	55	55	55	55	55

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

According to the analysis in Table 3. When analyzing CB, it is found that for every 1% increase in CB, lnIWD, lnISDE, and lnINE decrease by 0.0101%, 0.00469%, and 0.00672%, respectively, and passed the 1% significance test, indicating that the coverage of Ningxia's digital economy has a significant impact on industrial Wastewater discharge, industrial sulfur dioxide discharge, and industrial nitrogen oxide discharge have a negative inhibitory effect. The reason is that the development of digital economy coverage has prompted enterprises to adopt more advanced digital technology for production and management. This can include smart manufacturing, Internet of Things technologies, etc. These technologies can help companies control production processes more finely, reduce waste of raw materials, optimize energy use efficiency, and thereby reduce emissions of pollutants such as wastewater, sulfur dioxide, and nitrogen oxides. At the same time, the development of the coverage of the digital economy is often accompanied by the wider application of green energy, such as solar energy and wind energy. The use of these energies can reduce the energy consumption in the industrial production process, reduce the use of traditional energy such as coal burning, thereby reducing industrial pollutant emissions.

When analyzing UD, it is found that for every 1% increase in UD, lnIWD, lnISDE, and lnINE decrease by 0.0101%, 0.00469%, and 0.00672%, respectively, and passed the 1% significance test, indicating that the depth of use of Ningxia's digital economy has a significant impact on industry. Wastewater discharge, industrial sulfur dioxide discharge, and industrial nitrogen oxide discharge have a negative inhibitory effect. The reason is that the development of the digital economy has promoted technological innovation and management optimization in the industrial field. Through digital technology, enterprises can more accurately monitor, control and manage production processes, thereby reducing the discharge of waste water, sulfur dioxide and nitrogen oxides and other pollutants. Digital technology enables enterprises to monitor pollutant emissions in real time, find problems in time and take corresponding measures to reduce the level of pollutant emissions. At the same time, with the more convenient dissemination of information, the public's attention to environmental protection is also increasing. Consumers are more inclined to support environmentally friendly companies, which forces companies to improve production methods and reduce negative impacts on the environment. The development of the digital economy enables companies to better communicate with consumers and promote their own environmental protection measures, thereby forcing companies to reduce pollutant emissions.

When analyzing DL, it is found that for every 1% increase in DL, lnIWD, lnISDE, and lnINE will decrease by 0.0101%, 0.00469%, and 0.00672%, respectively, and passed the 1% significance test, indicating that the degree of digitization of Ningxia’s digital economy has a significant impact on industry. Wastewater discharge, industrial sulfur dioxide discharge, and industrial nitrogen oxide discharge have a negative inhibitory effect. The reason is that digital technology can help enterprises achieve refined management and optimization of the production process, thereby reducing waste of resources and waste of emissions. produced. Through real-time monitoring and data analysis, enterprises can more effectively adjust production parameters, improve production efficiency, and reduce unnecessary emissions; at the same time, the digital economy promotes the development of a circular economy, which reduces resources by recycling and reusing waste and by-products waste. Digital technology can provide more accurate data and information during resource recovery and reuse, thereby increasing the efficiency of recycling.

4.3 Robustness Test

Table 4. Core Explanatory Variables Lagged by One Period.

VARIABLES	(1) lnIWD	(2) lnISDE	(3) lnINE
L.IA	-0.00744***	-0.00401***	-0.00733***
	(-2.987)	(-2.859)	(-4.963)
PEE	-0.0757	-0.0321	0.00993
	(-0.967)	(-0.730)	(0.214)
GCRB	-0.0344*	-0.0131	-0.0145
	(-1.850)	(-1.257)	(-1.317)
AVS	0.0355***	0.0615***	0.0581***
	(3.692)	(11.38)	(10.20)
PD	-0.00363	0.00634***	0.00177
	(-1.161)	(3.600)	(0.954)
lnGDP	1.623***	-0.535*	0.522*
	(3.289)	(-1.927)	(1.783)
lnAICP	-0.0990**	0.0571**	-0.00992
	(-1.987)	(2.037)	(-0.336)
Constant	-14.65*	15.60***	0.524
	(-1.933)	(3.657)	(0.117)
R2	0.7723	0.8832	0.8929
N	50	50	50

z-statistics in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

According to the analysis in Table 4. In order to verify the reliability of the basic regression results, a one-period lagged robustness test was performed on the core explanatory variables. According to the test results, it can be found that for every 1%

increase in L.IA, lnIWD, lnISDE, and lnINE will decrease by 0.00744% and 0.00744% respectively. %, 0.00733%, and according to the analysis, it is found that the results are significant at the 1% level. Among them, R-squared is 0.7723, 0.8832, and 0.8929 respectively, indicating that the overall regression results have a strong explanatory ability, and the results are relatively robust and reliable.

5 Conclusions and Suggestions

Recent years have seen a rapid expansion of the digital economy, which has profoundly altered both the economic and social growth. Examples of these domains include government governance, business production, and resident life. In the background, this research is based on the 2011-2021 Using the mixed OLS model and different dimensions of the digital economy to empirically test the impact of Ningxia's digital economy on urban environmental pollution and its internal mechanism, the main conclusions are as follows: First, Ningxia's digital economy has significantly reduced urban environmental pollutants At the same time, after using the method of lagging explanatory variables for one period for robustness testing, the conclusion still holds true; second, when analyzing different dimensions of the digital economy, it is found that the coverage of the digital economy in Ningxia, the depth of the digital economy, and the digital economy The degree of digitalization has a negative inhibitory effect on urban environmental pollution, and it is significant at the 1% level, indicating that different dimensions of the digital economy help reduce urban environmental pollution emissions.

The expansion of the digital economy is helpful in reducing urban environmental pollution, so it should be energetically pursued, say the conclusions drawn above. Building a complete digital infrastructure system is a must for the growth of the digital economy. Create a system based on artificial intelligence, big data analysis, and the Internet of Things (IoT). The monitoring system monitors pollution sources, atmosphere, water quality, soil and other environmental factors in real time, and predicts pollution events in advance so that measures can be taken as soon as possible. Use digital technology to optimize urban planning, reduce energy consumption and carbon emissions. Intelligent transportation systems, smart power grids, etc. can reduce energy waste, optimize traffic flow, and reduce air pollution. Establish a digital environmental monitoring system to realize real-time monitoring and data sharing, and strengthen law enforcement and punishment for environmental violations. At the same time, formulate relevant policies to encourage enterprises to invest in digital environment protection technologies and innovations, and provide financial support, tax incentives and other incentives.

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