

A Study on The Impact of Digital Economy and Environmental Regulation on Attracting IFDI In China

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Abstract. This paper analyzes environmental regulation and digital trade in the same framework, and discusses the impact of environmental regulation, digital economy and their coupling effects on IFDI. Based on the panel data of 31 provinces from 2003 to 2021, a panel fixed effect model is constructed for empirical testing. The results show that environmental regulation can inhibit the inflow of IFDI. Digital economy can promote IFDI. The coupling effect of environmental regulation and digital economy can promote IFDI, and the promoting effect is more significant. Therefore, while accelerating the development of the digital economy, the state government should actively adjust the level of environmental regulations, so that they can promote each other, encourage enterprises to transform green and improve the awareness of intellectual property protection, promote the entry of high-quality foreign investment, and help the economy to achieve high-quality development.

Keywords: Environmental regulation; digital economy; IFDI.

1. Introduction

The report of the Twentieth Party Congress proposes that respecting nature, adapting to nature and protecting nature are inherent requirements for the comprehensive construction of a modern socialist country. Since the reform and opening up, China has been committed to creating a good business environment and constantly launching relevant preferential policies to attract a large amount of foreign capital. In 2021, China's actual utilization of IFDI amounted to 174.3 billion US dollars, an increase of 20.1% compared with 2020. Meanwhile the unregulated introduction of IFDI has led to serious environmental problems. Although the country has introduced a series of policies to change the traditional way of economic development, the ecological problems remain serious.

The State Council issued the "14th Five-Year Plan for the Development of the Digital Economy", which clearly states: "By 2025, the added value of the core industries of the digital economy will account for 10 per cent of the gross domestic product, the market system for data elements will be established initially, the digital transformation of industries will take a new step forward, the level of digital industrialization will be significantly raised, the public services of digitization will be more inclusive and equal, and the governance system of the digital economy will be more complete." By 2022, China's digital economy reached 50.2 trillion yuan, with a nominal year-on-year growth of 10.3 percent. Nowadays, the development of digital economy has become a global consensus, and data, digital technology, and digital infrastructure have become important location factors for multinational companies' location decisions. Therefore, how to attract IFDI by launching a new round of layout in the field of digital economy is the next issue to focus on.

This paper will use provincial data to empirically analyse the impact of environmental regulation and the digital economy on IFDI and put forward feasible suggestions for actively adjusting the level of environmental regulation and taking advantage of the development of the digital economy to attract high-quality IFDI.

2. Literature review and analysis of the current situation

2.1. Literature review

2.1.1 Impact of environmental regulations on attracting IFDI

Up to now, the research on environmental regulation on IFDI is more concentrated, and the research focuses on whether IFDI has a negative impact on China's environment and the extent of its impact. For example: Ruiyao Ying [1], on the basis of the "pollution shelter" theory, used econometrics to empirically analyses the relationship between foreign direct in-vestment and environmental problems, Yuming Wu [2] proposes that environmental regulations have a certain negative impact on the introduction of IFDI in various parts of China, Tianzi Li [3] highlights that the quality of IFDI can significantly contribute to the efficiency of green development.

2.1.2 Impact of the digital economy on attracting IFDI

Research on IFDI in the digital economy also focuses more on analysing the role of the digital economy through theory and empirical evidence. For example, Xiaoning Zhan [4] proposes that to face the rise of the digital economy, China's strategy of utilizing IFDI should be trans-formed from attracting investment to attracting intelligence and energy; Hao Li [5] analyses the impact of digital infrastructure, represented by the Internet, on IFDI. Lu Yuxiu and Fang Xingming [6] Based on theoretical analysis of the internal mechanism of digital economy affecting the location choice of IFDI, they empirically analyzed the impact of digital economy on the location choice of IFDI by using the two-way fixed effect model and found that digital economy affects IFDI by promoting digital finance and stimulating residents' entrepreneurial channels. It has found a new idea and provided an empirical basis for expanding opening to the outside world and stabilizing IFDI.

2.1.3 The joint impact of environmental regulation and the digital economy on attracting IFDI

Through the collection and collation of existing literature, it can be seen that there are more analyses on the individual impacts of environmental regulation and the digital economy on IFDI, and relatively few studies on the joint impacts of the two. The related studies mainly focus on the impact of environmental regulation and digital economy on the green technological innovation and total factor productivity improvement of enterprises. For example, Jian Ye [7] analyses that the digital economy plays a positive moderating role in the process of environmental regulation affecting green technological innovation through the heterogeneity test.

2.2. Analysis of the current situation

IFDI has promoted the high-quality development of China's economy. At present, IFDI in China presents the following characteristics: steady growth of total volume, concentration of funds in the tertiary industry, uneven distribution of capital sources [12]. Since the accession to WTO, with the improvement of the level of opening up, the actual utilization of foreign capital in China has increased significantly. After the financial crisis, the actual utilization of foreign capital has slowed down, but the long-term growth trend has not changed, and the growth rate tends to be stable. This is because this is because, with the continuous accumulation of China's capital stock, China's capital elements have become increasingly rich, at this time, the mode of introducing foreign capital has changed from simply pursuing quantity to pursuing quality.

China's total investment in environmental pollution control is increasing year by year, but it is worth noting that the proportion of investment in environmental governance in GDP has shown a downward trend since 2010. On the one hand, it shows the sustainability of China's GDP growth, and on the other hand, it increases the possibility of ignoring the problem of environmental protection due to development. Since reaching the peak of industrial pollution control in 2015, the overall investment has shown a gradual decline, which may be due to the fact that before 2015, because enterprises are experiencing the pains of transformation, in order to eliminate backward production capacity with high energy consumption, the state has more subsidy investment at this stage. In recent years, the

main body of economic development has been transformed into the tertiary industry, and the rise of a large number of high-tech industries and digital industries is itself conducive to reducing environmental pollution.

The development of China's digital economy will also be reflected in the following aspects: First, the construction of digital infrastructure has achieved remarkable results and achieved leapfrog development; Second, the innovation capability of the digital industry has been rapidly improved, and the core technology has been continuously improved. Third, industrial digitization is accelerating. Internet Plus, e-commerce, smart agriculture, and the industrial Internet are advancing in an all-round way. Fourth, the digitization of public services has continued to advance, mainly including the Internet plus government services, the improvement of the level of digital benefit to the people, and remarkable results have been achieved in rural digital construction. The digitization of public services has improved people's living standards and promoted common prosperity the government's investment in its mainly in high-tech research, rather than pollution control [13]. Due to space constraints, specific data charts are not shown in this paper.

3. Empirical analysis

3.1. Econometric modelling

Based on the theoretical analysis above, this paper uses IFDI as the explanatory variable, digital economy and environmental regulation as the core explanatory variables, and CVE denotes the control variable, and all the variables are logarithmic in order to weaken or eliminate the interference of heteroskedasticity on the estimation results.

This paper refers to Xiangyan Xu [8] research method, the benchmark regression model constructed is as follows:

$$FDI_{it} = \alpha_0 + \alpha_1 DIG_{it} + \alpha_2 CVE_{it} + \varepsilon_{it} \quad (1)$$

$$FDI_{it} = \beta_0 + \beta_{11} ERN_{it} + \beta_{12} ERN_{it}^2 + \beta_2 CVE_{it} + \gamma_{it} \quad (2)$$

Where i denotes the region, t denotes the time variable, CVE denotes the control variables, including the level of economic development, the level of human capital, the level of social consumption demand, the level of technological development, and the level of urbanization; and ε and γ denote the random perturbation terms.

Considering that there is a certain lag in the effect of the digital economy and environmental regulation, this paper selects the lagged period of the digital economy and environmental regulation as the explanatory variables and obtains:

$$FDI_{it} = \alpha_0 + \alpha_1 DIG_{it-1} + \alpha_2 CVE_{it} + \varepsilon_{it} \quad (3)$$

$$FDI_{it} = \beta_0 + \beta_{11} ERN_{it-1} + \beta_{12} ERN_{it-1}^2 + \beta_2 CVE_{it} + \gamma_{it} \quad (4)$$

To further discuss the impact of the digital economy and environmental regulations, and to consider the coupling effect of the two, an interaction term as the explanatory variables and obtains:

$$FDI_{it} = \lambda_0 + \lambda_1 ERN_{it} + \lambda_2 DIG_{it} + \lambda_3 CVE_{it} + \mu_{it} \quad (5)$$

$$FDI_{it} = \beta_0 + \beta_1 ERN_{it-1} + \beta_2 DIG_{it-1} + \beta_3 CVE_{it} + \eta_{it} \quad (6)$$

$$FDI_{it} = \delta_0 + \delta_1 ERN_{it-1} + \delta_2 DIG_{it-1} + \delta_3 ERN_{it-1} \times DIG_{it-1} + \delta_4 CVE_{it} + \eta_{it} \quad (7)$$

Where $ERN_{it-1} \times DIG_{it-1}$ is the interaction term between digital economy and environmental regulation, which is used to portray the impact of the coupling effect of digital economy and environmental regulation on industrial transformation.

3.2. Selection of variables

In order to ensure the availability of data, this paper will use the ratio of the end-of-year investment amount of foreign-invested enterprises to the number of registered households to measure the level of IFDI, there are two core explanatory variables in this paper: the Digital Economy Development Index and the level of environmental regulation. At present, there is no unified standard for the measurement of digital economy, and most of the existing authoritative institutions use comprehensive indexes [9] to measure and form an evaluation system of digital economy development indicators, as shown in Table 1. The same is true of environmental regulatory indicators.

Table 1. Digital economy comprehensive index measurement

Indicators	Tertiary indicators	Indicator weights
digital infrastructure	Long-distance cable routes (per kilometre)	0.154
	Broadband access ports (10,000)	0.125
Digital economy applications	Internet broadband penetration (%)	0.158
	Mobile phone penetration rate (units/100 population)	0.161
Digital industry development	Technology market turnover (billion yuan)	0.147
	Employment in information services (10,000 persons)	0.079
	Total telecommunication business (million yuan)	0.123
	Total number of express delivery operations (10,000)	0.053

And there are five control variables in this paper. The specific descriptions of the variables are shown in Table 2.

Table 2. Calculation of comprehensive indicators of digital economy

Variable name	Notation	Measurement
Overseas IFDI	fdi	Ratio of investment amount of foreign-invested enterprises to the number of registered households
Digital economy	dig	Composite index of digital economy development
Environmental regulation	ern	Composite index of environmental regulation
Level of economic development	gdp	GDP
Level of human capital	rz	Funding for education
Social consumption level	xf	Consumption expenditure per inhabitant
Level of technological development	js	Domestic patent applications received
Urbanization level	czh	Ratio of urban population to total population

3.3. Data sources and descriptive statistics

This paper selects the macro panel data of 31 provinces in China from 2003 to 2021 as the research sample. The data mainly come from *the China Urban Statistical Yearbook*, *China Statistical Yearbook*, and the statistical yearbooks of each province, and some missing data are processed by interpolation.

The descriptive statistics of the variables are shown in Table 3.

Table 3. Descriptive statistics

VARIABLES	N	mean	sd	min	max
lnfdi	589	2.120	0.669	0.379	6.614
Indig	589	8.807	0.664	6.207	10.40
lnern	577	11.56	1.323	2.303	14.16
lngdp	589	9.245	1.185	5.226	11.73
lnrz	589	15.37	1.049	11.93	17.80
lnxf	589	9.243	0.667	7.532	10.80
lnjs	589	9.841	1.851	3.178	13.80
lnczh	589	-0.664	0.295	-1.598	-0.110

3.4. Process of empirical analysis

3.4.1 Relevance analysis.

Prior to the regression analysis, the correlation analysis and covariance diagnoses of each variable were carried out in this paper, and the results show that the main explanatory variables used are all less than 4, and the others are all less than 10, and the meanVIF is 4.19, which indicates that there is no problem of multiple covariance. So, take the next step, model selection. Due to space limitations, the resulting table will not be shown in this paper.

3.4.2 Analysis of baseline regression results

Start by selecting the model, through several attempts to construct ols regression model, fixed effects model and random effects model, through the hausman test, chose the fixed effects model to regress the seven models con-structed in the first part sequentially, and the obtained regression results are shown in the graph in Table 4.

Table 4. Regression results

Models	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indig	0.481*** (0.124)				0.427*** (0.128)		
lngdp	-0.326* (0.141)	-0.274* (0.139)	-0.681** (0.214)	-0.543* (0.213)	-0.307* (0.139)	-0.630** (0.210)	-0.649** (0.209)
lnrz	-0.648*** (0.162)	-0.309 (0.165)	-0.739*** (0.178)	-0.375* (0.187)	-0.434* (0.170)	-0.480** (0.183)	-0.423* (0.184)
lnxf	0.859*** (0.212)	0.831*** (0.227)	1.259*** (0.271)	1.236*** (0.287)	0.788*** (0.225)	1.099*** (0.281)	1.075*** (0.280)
lnjs	0.264*** (0.067)	0.274*** (0.069)	0.282*** (0.072)	0.274*** (0.074)	0.226** (0.068)	0.238*** (0.071)	0.259*** (0.072)
lnczh	1.588*** (0.373)	0.789* (0.348)	1.782*** (0.390)	1.026** (0.373)	1.285*** (0.377)	1.623*** (0.386)	1.447*** (0.391)
lnern		0.131 (0.121)			-0.145*** (0.026)		
ln(ern ²)		-0.014* (0.006)					
L.Indig			0.621*** (0.125)			0.585*** (0.128)	0.616*** (0.128)
L.lnern				0.019 (0.184)		-0.178*** (0.029)	-0.148*** (0.032)
L.ln(ern ²)				-0.009 (0.008)			
Lngid×lnern							-0.008* (0.003)
_cons	1.374 (1.332)	-0.093 (1.451)	1.103 (1.492)	0.511 (1.693)	0.881 (1.347)	0.818 (1.471)	0.227 (1.500)
N	589	577	558	546	577	546	544

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 shows the impact of environmental regulation, the digital economy, and the coupling effects between the two on attracting international direct investment. Through models (1) and (3), it can be found that hysteresis increases the coefficient of both, and the digital economy level rises from 0.481 coefficient at 0.1% significance level to 0.621 coefficient at 0.1% significance level, which indicates that the impact of digital economy on IFDI does have a lag. Models (1) and (3) both indicate that digital economy has a positive effect on attracting IFDI, while in model (2) and (4), the marks before the two variables related to environmental regulation are inconsistent (although only environmental regulation has an insignificant impact on IFDI), which further reflects the uncertainty of the level impact of environmental regulation. Model (5) shows that if the joint impact of digital economy and environmental regulation is considered, first of all, the coefficient of environmental regulation becomes significant at the level of 0.1%, and the coefficient increases to -0.145, and the positive effect of digital economy on IFDI decreases to 0.427 after environmental regulation is added. Models (6) and (7) show that if the coupling effect of environmental regulation and digital effect is considered, the impact of digital economy on IFDI will be further increased, and the impact of environmental regulation on IFDI will be further reduced, making the final impact positive.

In addition to the core explanatory variables, the influence of control variables on FDI can be seen that the level of technology, consumption and urbanization have a positive impact on FDI, which is consistent with the empirical judgment, while the level of economic development and human capital have a negative impact on FDI, which seems to be inconsistent with the empirical hypothesis. My explanation for this is as follows: There is a strong correlation between the level of economic development and human capital. The higher the level of economic development, the higher the density of high-quality talents, the negative inhibition effect on IFDI is higher than the attraction effect, so the overall effect is negative. On the other hand, generally speaking, more economically developed regions or cities. Its capital stock is becoming saturated, and its investment focus may be on how to allocate outbound investment, rather than focusing on attracting IFDI.

3.4.3 Robustness test

In order to obtain data, this paper adopts missing variables to conduct robustness test. As there are many influencing factors of IFDI, this paper will select some influencing factors: Digital economy, environmental regulation, technical level, human capital level and urbanization rate. Meanwhile, in order to avoid endogenous problems caused by variable selection, explained variables are included in the model with a lag of one stage. The regression results are shown in Table 5.

Table 5. Robust regression results

Model	(1)	(2)
L.Indig	0.616*** (0.128)	0.634*** (0.128)
L.lnern	-0.148*** (0.032)	-0.152*** (0.033)
Lngid×lnern	-0.008* (0.003)	-0.009* (0.003)
lngdp	-0.649** (0.209)	
lnrz	-0.423* (0.184)	-0.241 (0.125)
lnxf	1.075*** (0.280)	
lnjs	0.259*** (0.072)	0.269*** (0.070)
lnczh	1.447*** (0.391)	1.687*** (0.391)
_cons	0.227 (1.500)	1.330 (1.437)
N	544	544

According to models (1) and (2), after the explanatory variables are omitted, the impact of environmental regulation, digital economy and their interaction terms on IFDI is consistent with the above. Therefore, the regression results in this paper are robust.

In conclusion, through the empirical analysis, it can be concluded that environmental regulation has an inhibitory effect on the introduction of IFDI; Digital economy can promote the inflow of IFDI, and its effect is greater than that of environmental regulation. The combined effect of environmental regulation and digital economy will offset part of the inhibition effect of environmental regulation, resulting in the reduction of the inhibition effect of environmental regulation on IFDI. The coupling effect of the two can significantly promote the entry of IFDI, and its promoting effect is greater than that of digital economy alone. It shows that the proper combination of environmental regulation and digital economy will be more conducive to attracting high-quality IFDI.

4. Conclusions and suggestions

Environmental regulation has an inhibitory effect on the inflow of IFDI; digital economy has a promotional effect on attracting IFDI; the coupling effect of the two has a promotional effect on IFDI, and the promotional effect is more significant. Therefore, while the development of the digital economy, the level of environmental regulation should be actively adjusted so that they can promote each other, initiatives the green transformation of enterprises and improve the awareness of intellectual property protection, promote the entry of high-quality foreign investment, and help the economy achieve high-quality development.

4.1. Continue to attract investment and control pollution simultaneously

Abandon the practice of "environment for development" and pay attention to environmental protection while actively introducing IFDI. With environmental regulations as the entry threshold for IFDI, we should actively introduce high-quality IFDI with green environmental protection and advanced technology. At the same time, we can also establish an incentive mechanism for green investment, give certain concessions to green investment, and actively guide the imported foreign

capital to carry out green transformation. We will strengthen supervision, appropriately punish IFDI with serious pollution, and force it to carry out green technology innovation [10].

4.2. Flexibly adjusting the level of environmental regulation

Improve the relevant system and tool system of environmental regulation and create the basic conditions for better attracting high-quality IFDI. Formulate environmental regulation policies according to local conditions, curb the blind development of high energy consumption industries, promote enterprises to accelerate green transformation, and achieve sustainable economic development [11]. For economically underdeveloped areas, the government should appropriately reduce the enforcement of environmental regulations and improve the level of infrastructure construction to attract IFDI. For areas with higher levels of economic development, the government should implement strict environmental regulations, introduce advanced production technology and green production processes to improve resource utilization efficiency and ease the pressure on domestic investment in environmental pollution control. Of course, environmental regulation also needs to be grasped to a certain extent, and excessive environmental regulation will lead to a double decline in the scale and quality of foreign capital inflow.

4.3. Actively promoting the development of the digital economy

Actively promote the development of digital economy and promote the penetration of digital economy in various fields such as economic society and industrial development. On the one hand, we should promote the development of digital industrialization, improve the construction of intelligent digital infrastructure, train digital talents, constantly promote digital technology innovation and digital product innovation, and provide technical fulcrum for urban innovation and development. On the other hand, deepen the development of industrial digitalization, apply digital products, digital technologies and digital formats to the real economy, improve the resource allocation capacity and resource utilization efficiency of the real economy, and promote its innovative development. At the same time, the government should improve the urban infrastructure, create a good environment for innovation, strengthen the training of innovative talents, encourage enterprises to increase investment in their own research and development, improve the innovation mechanism of enterprises, improve the ability of independent innovation, and better absorb foreign advanced technology to inject new vitality into economic development.

4.4. Digital economy and environmental regulation help each other

Choose the development path of digital economy scientifically, formulate reasonable development models according to different levels of urban development, and match appropriate environmental regulations to maximize the combined effect of the two. The development level of China's digital economy is extremely unbalanced. For cities in the initial stage of digital economy, they should make up for their shortcomings, be demand-oriented, introduce IFDI, and appropriately relax the threshold of environmental regulation. For cities leading the development of digital economy, they should continue to play their leading and exemplary role, form unique advantages in the field, and appropriately raise the requirements of environmental regulation. To attract high-quality IFDI inflow.

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