A Study on the Influence of Digitization Level on Environmental Performance of Resource-based Enterprises in Guangxi

Jiapei Wei [1], Zhenghua Deng[2], Tongchao Zhang[3], Jiajun Wan[4], Xue Gong[1,*]

[1]School of Business Administration, Guangxi University of Finance and Economics, Nanning, China
[2]School of Economics and Management, Hunan Institute of Science and Technology, Yueyang, Hunan, China
[3]College of Management, Sichuan Agricultural University, Chengdu, China
[4]School of Business, Guilin university of electronic technology, Guilin, China

*X.G. corresponding author: 2019220055@gxufe.edu.cn

Abstract. Resource-based enterprises play a pivotal role in driving local economic growth and social development. This study examines resource-based listed enterprises in Guangxi from 2000 to 2022, leveraging the CSMAR database as the primary data platform to empirically investigate the interrelationships among digitalization, environmental performance, enterprise's internal control level and environmental regulation. The results are as follows: (1) The digitalization level of resource-based enterprises has a positive impact on enterprise environmental performance; (2) Digitalization level can improve enterprise environmental performance by enhancing internal control; (3) Environmental regulation has a positive moderating effect on the relationship between digitalization level and corporate environmental performance. Therefore, some suggestions are put forward accordingly; At the macro level, government departments should accelerate the establishment and improvement of sewage fee and sewage tax systems, and give full play to the positive moderating effect of environmental regulation on the relationship between digitalization level and enterprise environmental performance by formulating stricter pollutant discharge standards and introducing supportive policies on capital, technology, talent and new infrastructure construction; At the micro level, resource-based enterprises should take the initiative to improve digital awareness, stimulate green innovation ability, promote the innovative application of digital technology, attach importance to the construction of digital talent team, and give full play to the transmission role of internal control between digital level and enterprise environmental performance.

Keywords: digitalization level; environmental performance; resource-based enterprises.

1   Introduction

Resource-based enterprises are traditional manufacturing industries with natural resources as the labor object, involving 15 industries such as steel, cement, non-ferrous metals, petrochemical, chemical, coal chemical, thermal power, etc. They play a pivotal role in local economic and social development. In Guangxi, 210 non-ferrous metal enterprises have provided 84,000 jobs for the society and solved the food and clothing problems of a large number of workers, which is of great significance to social stability and border peace. Among the Guangxi enterprises listed in top 500 enterprises in China's manufacturing industry, resource-based enterprises account for 77.8%, which has become an important supportive force for local economic development. Among the top 10 private enterprises in Guangxi, resource-based enterprises account for 2/5, significantly contributing to enhancing local finance. However, behind the rapid economic growth, the development mode of "high input, high energy consumption, high pollution and low efficiency" of resource-based enterprises has become unsustainable. This paper will deeply explore the following issues: What is the impact of digitalization level on the environmental performance of resource-based enterprises? What is the underlying mechanism? What role does environmental regulation play in the process of increasingly improved digitalization level affecting the environmental performance of resource-based enterprises? It aims to find an effective way to improve environmental performance while ensuring economic performance of resource-based enterprises.

2   Literature Review

Previous research closely related to this paper mainly focuses on the following three aspects: (1) Research on the impact of digitalization level of resource-based enterprises. Existing studies have mainly explored the impact of digital transformation of resource-based enterprises on total factor productivity (You et al 2023)[1], innovation performance (Duan et al., 2022)[2], green technology innovation (Wang et al 2021)[3] and other aspects. (2) Research on the influencing factors of environmental performance of resource-based enterprises. Existing studies mainly focus on ecological pressure and government regulation (Xue LL,2021)[4] and other macro factors, industrial agglomeration and industrial environment and other meso factors (Li et al., 2011)[5], and micro factors such as resources (Leonidou C.L., 2017)[6], organization (WangT,2015)[7], technology (Xie et al.,2019)[8] and strategy (Wei et al., 2023)[9]. (3) Research on the relationship between digitalization level and environmental performance of resource-based enterprises. Although no relevant research on resource-based enterprises has been found, some literature has confirmed that the improvement of digitalization level of manufacturing enterprises and heavy polluting enterprises is conducive to the improvement of enterprise environmental performance (Dai et al., 2022)[10].

By reviewing the literature, it is found that the existing research still has the following shortcomings: (1) The research on the relationship between digitalization level and environmental performance is not sufficient, which leads to many uncertain factors

in the practice of using digital empowerment to improve environmental performance of resource-based enterprises. (2) From the perspective of research region, most of the existing literature takes Shanxi and other old industrial bases as the research object, and some of the research on the resource-based economy in border areas mainly focuses on the northwest border areas such as Xinjiang. There is an obvious shortage of the research on the southwest border areas. (3) From the perspective of resource types, most of the existing research focuses on the areas rich in coal or oil and natural gas resources, and there are few studies on non-ferrous metal and non-metallic mineral resources.

3   Research Hypotheses

Li Kun et al. (2024)[11] studied the samples of heavily polluting enterprises in China's A-share market from 2017 to 2021 and found that digital transformation has a significantly positive impact on the environmental performance of those heavily polluting enterprises. Resource-based enterprises are classified as traditional manufacturing enterprises with high pollution and high emission, so they may also have the aforementioned characteristics. Based on this, this paper puts forward the following hypothesis:

H1: Digitization level has a positive impact on the environmental performance of resource-based enterprises.

Qi et al. (2022)[12] found that the efficient transmission of digital information could effectively prevent the adverse impact of shareholders' abuse of power or data tampering on the environmental performance of enterprises. Tian et al. (2010) [13]pointed out that strengthening the internal control of enterprises not only helped to improve the operation efficiency of enterprises, but also enhanced the ability of enterprises to fulfill their social responsibilities. The improvement of enterprise digitalization level is conducive to improving the internal control of enterprises, thus reducing the waste of resources.

H2: Digitalization level can improve the environmental performance of resource-based enterprises by enhancing internal control.

Ye Hongyu (2017)[14] proposed that when faced with the pressure brought by environmental regulation, enterprises often chose to increase R&D investment, thus promoting the process of green innovation. This kind of innovation can not only improve production efficiency, but also help to reduce resource consumption, thus reducing the negative impact on the environment.

H3: Environmental regulation positively moderates the relationship between digitalization level and the environmental performance of resource-based enterprises.

4   Research Design

4.1   Model Construction

Referring to the research of Du X.Q. et al. (2021)[15], this paper constructs the following model:

$$CEP = \alpha_0 + \alpha_1 \text{Dig} + \alpha_2 \text{control} + \sum \text{Year} + \varepsilon \text{it} \qquad (1)$$

In Model (1), CEP is a measure of enterprise environmental performance, and Dig is a measure of enterprise digitalization level. At the same time, the model controls the variables of corporate operation and governance.

4.2   Variable Description

4.2.1 Explanatory Variables.

Following the methodology of Zhao C.Y. (2021)[16], the explanatory variables is assessed by 99 digital-related high-frequency words across four dimensions: digital technology application, internet business models, intelligent manufacturing, and modern information systems. The digitalization level is measured by three steps:(1) Collecting the annual reports of listed resource-based enterprises in Guangxi from 2000 to 2022, converting them into text format, and extracting the operational analysis sections.(2) counting word segmentation and word frequency on the selected samples to screen out high-frequency words related to digitalization level. Those high-frequency words then are summarized into four keywords: digital technology application, Internet business model, intelligent manufacturing and modern information system.(3) according to the selected thesaurus, the Python statistical function is used to conduct statistical processing on the collected annual reports of listed companies, and the summary is made according to the characteristics of the words.

4.2.2 Explained Variable.

Referencing the approach of Zhang C. (2020)[17], sewage charge is selected as the proxy variable to measure corporate environmental performance. Since 2018, China has officially changed the pollutant discharge fee into environmental protection tax, so the pollutant discharge fee from 2018 to 2022 was replaced by environmental protection tax.

4.2.3 Control Variables.

Referring to the related research of Zhang R.et al (2023)[18], definitions of control variables are shown in Table 1.

Table 1. Variable Definition Table

	Variable names	Variable symbol	Variable description
Explained variable	Corporate environmental performance	CEP	Ln(sewage charge/environmental protection tax)
Explanatory variables	Enterprise digitization level	Dig	Enterprise digitization level index
Moderating variables	Environmental regulation	Rule	(Completed investment in industrial pollution control/industrial added value) ×1000
Mediating variable	Internal control	InIC	Dib Internal Control Index
	Enterprise size	Size	Ln(number of employees)
	Board size	Board	Ln(number of board members)
	Percentage of shares held by institutional investors	Inst	The proportion of investment institutions in the number of shares
	Shareholdings of major share-holders	Lhold	Percentage of shareholding held by the largest shareholder
Control variables	Two in one	Dual	1 if the chairman and general manager are the same person, 0 otherwise
	Return on total assets	ROA	Net profit/average total assets for the year
	Asset-liability ratio	Lev	Total ending liabilities/ending assets
	Percentage of independent directors	Indep	Number of independent directors/directors
	Age of enterprise	Age	The length of time the business has been in existence
	Year	Year	Year dummy variable

4.3   Data Source and Sample Selection

This paper selects the Guangxi's resource-based enterprises listed in Shanghai and Shenzhen Stock Exchanges from 2000 to 2022 as the research object, and selects them according to the following principles: (1)Samples with incomplete data related to enterprise digitalization level and environmental performance are removed; (2) The resource-based industry segmentation method of Ma J. (2023)[19] is adopted, i.e.. After screening, 1717 data were finally obtained from CSMAR database, the website of Tax Bureau, Dibo Big Data Research Center and WIND database.

5   Empirical Analysis

5.1   Descriptive Statistical Analysis

Descriptive statistics analysis reveals that the standard deviation of the digitization level of sample enterprises is 8.153, the minimum value is 0, and the maximum value is 37, indicating that the digitization level of sample enterprises varies greatly. The median is 5, and the mean is 8.069. More than half of the enterprises' digitization level does not reach the average level, and the overall level is low. The standard deviation of

the sample enterprises' environmental performance is 1.609, the minimum value is 11.779, the maximum value is 18.706, the median is 14.776, and the mean value is 15.073, indicating that the overall level of the sample enterprises' environmental performance is not high. The mean of internal control of sample enterprises is 605.291, the median is 664.84, indicating that more than half of the sample enterprises' internal control has reached the industry average level. The standard deviation is 226.507, the minimum value is 0, and the maximum value is 922.910, reflecting the huge gap in the level of internal control among sample enterprises.

5.2   Correlation Analysis

The correlation analysis indicates that the correlation coefficient between the digitization level index used in this paper and the enterprise environmental performance is 0.408, and it is significant at the level of 5%, indicating that there is a positive correlation between the digitization level and the environmental performance of the sample enterprises, which preliminarily verifies H1: digitization level has a positive impact on the enterprise environmental performance. This provides a preliminary basis for the hypothesis of this paper.

5.3   Regression Analysis

The regression results shows that when no control variables are included, the regression coefficient of the explanatory variable Dig is 0.080, which is significant at the level of 5%. After the dummy variable of year is added in Column 2, the coefficient of explanatory variable Dig is 0.077, which is significantly positive at the level of 5%. In the regression results of the third column, after adding the control variable and the dummy variable of year, the coefficient of the explanatory variable Dig is 0.054, which is significantly positive at the level of 5%. This shows that when other conditions are certain, the higher the digitalization level of an enterprise is, the better the environmental performance of the enterprise is. The regression results further verify hypothesis H1 proposed in this paper.

5.4   Robustness Test

The specific classification and keywords are referred to the research of Wu F.(2021)[20]. The digitalization levels are redefined into five categories: big data technology, cloud computing technology, artificial intelligence technology, digital technology applications, and blockchain technology. According to the regression results after adjusting the classification of digitization level, without adding any control variables, the regression coefficient of explanatory variable Dig_new is 0.241, which is significantly positive at the 5% level. When year dummy variable is added, the coefficient of explanatory variable Dig_new is 0.219, which is significantly positive at the level of 10%. When year dummy variables and other control variables are added, the coefficient of explanatory variable Dig_new is 0.169, which is significantly positive at the level of 5%. The results of the robustness test show that no matter which classifi-

cation standard is adopted, there is no substantial change in the sign and significance level of the regression coefficient of the explanatory variable in the corresponding equation, but there is a slight difference in the numerical size, which indicates that the empirical results of this paper are robust and reliable.

5.5   Mechanism Testing

To examine the pathways by which digitalization impacts corporate environmental performance, this study empirically tests the mediating effect of internal control and the moderating effect of environmental regulation. The results are as follows:(1) Mediating Effect of Internal Control. Digitalization and internal control both show significantly positive effects at the 5% level, with coefficients of 0.065 and 0.002, respectively. This indicates that digital transformation enhances environmental performance by improving internal control, supporting Hypothesis H2.(2) Moderating Effect of Environmental Regulation. The interaction between digitalization and environmental regulation is significantly positive at the 5% level, with a coefficient of 0.014. This suggests that environmental regulation positively moderates the relationship between digitalization and environmental performance in Guangxi's resource-based enterprises, supporting Hypothesis H3.

6   Conclusions and Suggestions

6.1   Research Conclusions

The research conclusions are as follows: Firstly, there is a significant positive relationship between enterprise digitalization level and enterprise environmental performance: the higher the digitalization level of resource-based enterprises in Guangxi is, the better the environmental performance is. After the stability test, the above conclusions are still valid. Secondly, through the intermediary mechanism test, it was found that the relationship between enterprise digitalization level and enterprise environmental performance can be transmitted through internal control. That is, digital transformation can significantly improve the internal control of enterprises, affect the level of internal governance of enterprises and eventually improve the environmental performance. Thirdly, through the moderating effect test, it was found that environmental regulation has a positive moderating effect on the relationship between enterprise digitalization level and enterprise environmental performance. Appropriate environmental regulation is conducive to the improvement of enterprise environmental performance.

6.2   Policy Suggestions

(1) Macro level: Firstly, we should eliminate existing institutional barriers, accelerate the establishment and improvement of pollution fees and taxes, and create a favorable institutional environment for resource-based enterprises to enhance their digital level

and improve their environmental performance. Secondly, government departments should establish stricter pollutant emission standards and increase the external driving force for resource-based enterprises to improve their environmental performance through digitalization. Thirdly, government departments should introduce corresponding supportive policies in terms of capital investment, digital technology, talent introduction, and new infrastructure construction to resolve the practical difficulties faced by resource-based enterprises in improving environmental performance through enhancing their digital level.

(2) Micro level: Firstly, resource-based enterprises should actively enhance their digital awareness, and fully leverage the driving effect of digitalization on environmental performance by stimulating green innovation capabilities, promoting innovative applications of digital technology, and other means. Secondly, resource-based enterprises should attach importance to the construction of digital talent teams, and provide human resource support for resource-based enterprises to enhance their digital level and improve environmental performance through various measures such as increasing investment in human capital, optimizing personnel structure, and improving talent cultivation mechanisms.

The results of this study are applicable not only to resource-based enterprises in Guangxi but also offer insights for other regions and industries.

Funded Project

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