

Research on the Relationship between Internationalization and Corporate Environmental Responsibility Strength: The Moderate Effect of Digital Transformation and Environmental Regulation

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Abstract. Currently in the stage of global digital transformation, internationalization is largely linked to the digitization of enterprises. The study of the relationship of internationalization on corporate social responsibility (CSR) has been a focus of research, and we deepen it further by focusing on heavily polluting small and medium-sized enterprises (SMEs) in China to find the influence of internationalization on the corporate environmental responsibility strength (CERs) according to institutional theory. In addition, digital transformation and environmental regulation which are political factor-related variables, affect the relationship between internationalization on CERs. Using data from 152 heavy polluting firms listed on the GEM from 2011-2021, we empirically find that internationalization has a positive influence on CERs. Moreover, this relationship varies according to digital transformation and environmental regulation. Specifically, when the digital transformation level is high, it migrates the positive effect of internationalization on CERs, while the environmental regulations also migrate the positive effect of internationalization on CERs. Our research is conducive to promoting the internationalization level of companies in the context of digitization, and at the same time, it is conducive to increasing companies' environmental awareness and developing green computer science research, while providing practical recommendations to fuel sustainable Internet and digital innovation.

Keywords: Internationalization; Corporate environmental responsibility strength; Digital transformation; Environmental regulation

1 Introduction

Currently, in the context of digitization, combining internationalization and CERs with computer science is an important task, which helps to promote global cooperation and sustainable development. Therefore, the integration of green computer technology, including the use of data analysis to process environmental data and the development of intelligent detection systems to provide environmental information, can help governments make better decisions, and therefore the study of the relationship between internationalization and CERs, as well as the moderate effect of digital transformation and environmental regulation, can help to enhance the better use of computer science and digital technology by enterprises to improve their internationalization and fulfillment of CERs during the internationalization under the context of digitalization.

Enterprise internationalization has recently grown in importance as a result of changing markets and surroundings, but it is often accompanied by difficulties to an organization's legitimacy and institutional viability. While corporate environmental responsibility is the firm's commitment to protecting the environment ^[1]. According to Dowell and Muthulingam (2017)^[2], CERs involve businesses taking ethical actions to better the environment and meet stakeholder expectations. By using these steps, firms can forge solid connections with their external stakeholders and access their network of contacts for resources ^[3]. The relationship between internationalization and a company's CSR performance has received the majority of attention in previous research, with less attention paid to internationalization's effect on CERs alone. The research shows that corporate involvement in environmental responsibility can improve resources utilization efficiency, and respond to key institutional pressures ^[4]. We mainly focus on corporate environmental responsibility strength, it aids companies in building strong connections with external stakeholders ^[5], and shape the goal for companies to protect and strengthen the environment behaviors ^[2].

At the same time, as economic development force in our country, heavily polluting companies have more impact on the environment and are more sensitive to environmental problems ^[6]. In this context, how to achieve economic and environmental coordination and green development is not only the social responsibility that enterprises should fulfill, but also an important way to achieve the sustainable development goals ^[7]. Therefore, according to the development situation of heavily polluting companies in China, studying internationalization and CERs will help to better understand the relationship between internationalization and CSR.

In addition, within the realm of digitization, digital technology stands out as a pivotal catalyst for enterprise internationalization ^[8]. To delve deeper into this dynamic landscape, we use digital transformation and environmental regulation as the moderate variables. The emergence of digital technology has also brought many controversial results, although many literature suggests that digital technology can enhance the internationalization strategy of enterprises ^[9], some literature suggests that digital transformation may also have a negative impact on enterprise internationalization ^[10]. Recent research underscores that the positive influence of digital technology on internationalization is contingent upon its integration into processes, coupled with investments in innovation and digital skills ^[11]. And then, Building on the insights of Jamali and Karam ^[12], it is imperative to consider environmental regulation in China as a crucial element within the regulatory framework. This regulatory framework serves as a reflection of institutional pressures on enterprises concerning environmental responsibility. In the context of institutional pressures, environmental regulation emerges as a significant dimension, mirroring the legitimacy pressures faced by enterprises ^[13]. Therefore, the study on the impact of digital transformation and environmental regulation on internationalization and CERs remains an area with unresolved questions and complexities.

In these instances, our objective is to address two research queries: (1) How is the connection between internationalization and the strength of environmental responsibility in heavily polluting SMEs in China? (2) Whether and how digital transformation influence the CERs during the internationalization, and the influence of environmental regulation. On this basis, we based on institutional theory, choose the heavily polluting SME companies as sample from GEM, select panel data from 2011-2021, and contained 152 firms. Then empirically test the impact of internationalization on CERs, and testing the moderate effect of digital transformation

and environmental regulation in this process. The end result is to propose policy ideas that can promote enterprise internationalization and CERS.

2 Theoretical framework and hypothesis development

2.1 Internationalization and CER strength among Chinese heavily polluting SMEs

Corporate environmental responsibility is the firms' commitment to environmental protection^[1]. According to Dowell and Muthulingam^[2], CERs entails businesses taking responsible actions that aim to protect and strengthen the environment behaviors. It also helps to build up a positive reputation and may result in a potential reduction in legal costs^[4], as a result, investors may more likely to increase their investments in businesses and reduced resource costs for the enterprise, while Wu, Liang and Zhang^[15] found that CERs is positively related to corporate innovation success. Additionally, CERs helps companies build positive ties with governments^[16], for it not only complies with environmental requirements but also lessens the burden on governments to maintain the environment.

Research shows that internationalization brings legitimacy pressure to companies^[17], while Xu et al. (2022)^[18] empirically find that the CER of Chinese listed companies will positively influence the innovation legitimacy. They need to seek external legitimacy to enhance their reputation because corporate reputation can play a protective role in the competitiveness of the firm^[19] and the performance of the companies will be impacted and it will create values for companies^[20]. And the research shows that corporate involvement in environmental responsibility can enhance resource utilization efficiency and address critical institutional pressures^[4]. Moreover, heavily polluting companies exert a greater environmental impact and demonstrate heightened sensitivity to environmental issues^[6], greater need for active disclosure of environmental information^[21], Enhancing corporate reputation through environmental responsibility. In short, both the legitimacy and reputational requirements of companies in the internationalization process increase the demand for heavily polluting SMEs to actively improve their environmental responsibility strength and make them actively fulfill their environmental responsibilities. We, thus, postulate the hypothesis below:

Hypothesis 1. Internationalization is positively related to CER strength.

2.2 Moderations of digital transformation

We have already pointed out that internationalization strengthens CERs. We further argue that digital transformation would mitigate this positive relationship. Although the study shows digital tech can be a driver for internationalization^[22], and research has found that only by embedding digital technology into processes and investing in innovation and digital skills can digital technology have a positive impact on internationalization^[11], it will bring legitimacy issues and changes in the company's global business scope.

Also, The development of the digital economy coincides with an environmental crisis, corporate environmental responsibility is the firm's commitment to protecting the environment^[1]. Thus, we consider that enterprise digital transformation can actually hinder them from fulfilling CERs in the process of internationalization. In view of the above analyses, we draw the following hypothesis:

Hypothesis2. Digital transformation migrate the positive effect of internationalization on CER strength.

2.3 Moderations of environmental regulation

Environmental regulation as a political factor, represents the government's regulatory pressure, from the institutional theory, organizational behavior of companies and economic activities are highly constrained by the institutional environment of the country [23]. According to certain studies, it is simpler to encourage businesses to generate green innovation awareness, build coping mechanisms, and effectively lower the green barriers in order to acquire legitimacy at home and abroad the more environmental regulatory pressure there is. In addition, the greater the regulatory pressure, the more it can bring professional endorsement for multinational enterprises, which can help companies to obtain overseas legitimacy status [24].

The pollution havens hypothesis, however, contends that environmental regulations may harm the CERs of businesses that are expanding internationally. Specifically, Fan et al. (2019)[25] find that, companies may be less likely to internationalization themselves as a result of environmental rules if they are more willing to invest than innovate so as to achieve technical advancement. In conclusion, we believe that the impact of environmental regulations is multifaceted. In sum, we propose that environmental regulation moderates the relationship between internationalization and CERs. This brings us to our next hypotheses:

Hypothesis3. Environmental regulation migrate the positive effect of internationalization on CER strength.

The conceptual model is delineated in **Figure1**.

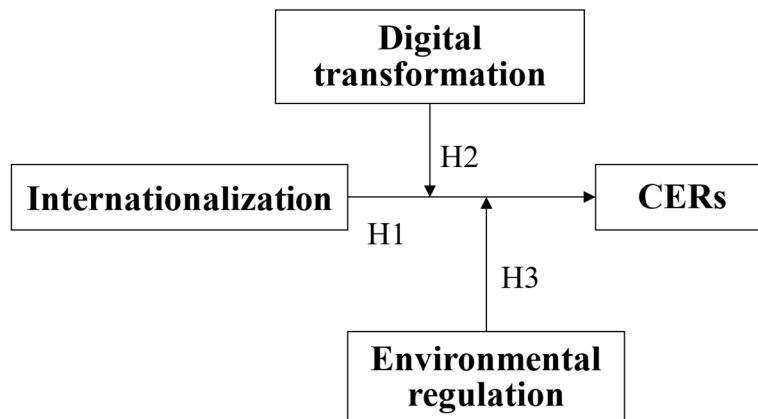


Fig. 1. Research framework

3 Methodology

3.1 Sample and procedure

The sample of this study is the heavily polluting industries [6] listed on the GEM from 2011 to 2021. This selection is driven by two factors: (1) ensuring sample reliability, as per regulatory

requirements mandating companies on the GEM to disclose comprehensive and accurate data of corporate environmental and corporate performance adhering to international standards, and (2) strong alignment with the objectives of this study. Research shows that internationalization brings legitimacy pressure to companies [17], As economic development force in our country, Environmentally impactful companies that heavily pollute tend to be more susceptible to environmental issues [6], thus, they are more susceptible to political during internationalization. Therefore, the heavily polluting firms in GEM provide us a good sample to test the hypotheses. For the accurate of the study, we adjust the original samples as following procedure:

(1) this paper choose companies that in heavily polluting industries based on the research of Ren et al. (2021)^[6]; (2) Companies with poor performance in ST, ST*, and PT categories were excluded, and (3) we deleted the sample with missing value. We introduced a 1-year lag to capture the delayed effects of digital transformation and environmental regulation on internationalization. Consequently, 9 enterprise samples were eliminated. Our final dataset comprised 1110 firm-year observations from 152 firms, primarily sourced from the CSMAR database and annual reports of listed companies.Measures

3.1.1 Dependent variable: Corporate environmental responsibility strength

We measure CER strength by CERs score [15, 26]. It consists of 5 classes, the items of CERs include (1) Companies are recognized for offering environmentally friendly products or services. (2) Emphasis is placed on take use of the clean or renewable energy and resources to ease environmental impact. (3) Measures to prevent pollution, including reduced emissions and the minimization of toxic substance usage, are considered. (4) Recycling efforts involve the reuse of waste energy or resources in company operations. (5) Companies with an environmental management system certificate (ISO14001) are acknowledged. All items carry equal weight. We extracted monetary and quantitative data from annual reports, CSR reports, and sustainability reports, categorizing the information into these items. The CERS score is calculated by summing up the values of these items.

3.1.2 Independent variable: Internationalization

According to the findings presented by Yang et al. (2022)^[27], our approach employs the Inter framework for internationalization assessment. This framework hinges on principal component analysis, incorporating key metrics such as the ratio of a firm's foreign sales to its total sales (Sales), the natural logarithm transformation of the count of foreign subsidiaries (Company), and the natural logarithm transformation of the count of distinct foreign countries in which the firm operates (Nation). Additionally, we subject our methodology to a robustness test using the Company metric.

3.1.3 Moderate variables

3.1.3.1 Digital transformation

The integration of computer technology, including the use of data analysis to process environmental data and the development of intelligent detection systems to provide environmental information. Following Wu et al. (2021) [28]we choose five key words of digital transformation, big data, cloud computing, blockchain, artificial intelligence, and digital technology applications, and used Python crawler function to extract text contents using Java

PDFbox library, creating data pool for subsequent feature word filtering, finally collects and organizes the results in this study. And we use “Digital” represents digital transformation in the study.

3.1.3.2 Environmental regulation

In this paper, we matched annually according to the place of registration of the enterprise, use the natural logarithm of provincial investment in environmental pollution control to measure environmental regulation ^[29].

3.1.4 Control variables

Many factors are thought to mirror a company's condition, such as firm size, age, debt, ROA, and industry. Consequently, these variables are managed in this study. Additionally, to account for digital transformation and environmental responsibility, we control for capital intensity (Capital), institutional ownership (Stitution), intangible assets (Intangible), and R&D intensity (Resratio). Furthermore, given the sample spans from 2011 to 2021, eleven annual dummy variables are introduced in this study.

4 Results

4.1 Descriptive statistics and correlation analysis

Table1 displays the results of the descriptive statistics and correlation analysis of the variables in this study. We employed the variance inflation factor (VIF) to tackle multicollinearity. The outcomes indicate that all the related variables' VIF values are below 2, indicating a low likelihood of a significant multicollinearity issue in the model.

Table1. Results of descriptive statistics and correlations

	Mea	Std.	1	2	3	4	5	6	7	8	9	10	11	1
1.C	2.19	2.95	1											2
ERs	5	7												
2.In	0.30	0.44	0.00	1										
ter	5	6	700											
3.Di	0.57	0.84	0.15	0.23	1									
gital	6	6	5**	2**										
			*	*										
4.R	0.00	0.00	-	-	-	1								
egul	23	17	0.12	0.15	0.02									
atio			1**	7**	80									
n			*	*										
5.R	0.02	0.03	0.01	0.16	0.14	-	1							
esra	17	48	90	5**	3**	0.29								
tio				*	*	6**								
						*								
6.R	0.05	0.05	-	-	-	-	-	1						
OA	67	81	0.15	0.16	0.09	0.01	0.05							
						70	8*							

	Mean	Std.	1	2	3	4	5	6	7	8	9	10	11	12
			1** *	8** *	8** *									
7.In tang ible	0.04 0	0.02 77	0.00 500	- 0.12 3** *	- 0.12 5** *	0.15 2** *	- 0.08 5** *	- 0.10 1** *	1					
8.Fi rmsi ze	21.2 5	0.72 2	0.18 2** *	0.27 9** *	0.20 5** *	- 0.07 6**	0.18 1** *	- 0.17 9** *	- 0.14 0** *	1				
9.Fi rma ge	14.8 4	5.58 8	0.05 9*	0.07 9** *	0.06 2**	- 0.21 3** *	0.32 0** *	0.02 60	- 0.04 20	0.12 4**	1			
10.F irm debt	0.28 3	0.15 9	0.23 0** *	0.24 1** *	0.11 7** *	- 0.03 00	0.03 60	- 0.42 2** *	0.02 70	0.35 8** *	0.11 5** *	1		
11.S titut ion	20.7 0	22.6 3	- 0.01 10	0.02 70	0.00 900	0.07 2**	0.01 00	0.05 3*	- 0.00 300	- 0.05 9**	0.06 5**	- 0.03 70	1	
12. Cap ital	0.23 1	0.11 5	0.01 50	0.02 90	- 0.10 2** *	0.09 7** *	- 0.05 8*	- 0.18 1** *	0.17 5** *	- 0.08 9** *	0.02 60	0.12 2** *	0.0 30	1 0

4.2 Hypothesis testing

We utilized Stata 17.0 to conduct data analysis and performed the Hausman test to ensure the inclusion of all pertinent variables in the model. Consequently, we opted for a fixed effects model in our study. It's worth noting that biases in data statistics may introduce outliers in enterprise data, potentially impacting the empirical findings of this article. Therefore, we performed tail reduction at the 1% and 99% quantiles to avoid the impact of outliers. We use the xtsc- Stata module, which is used to fit fixed or random effects models while considering the time series structure of panel data.

Table2 shows the empirical results of the regression analysis. Hypothesis1 suggests that internationalization positively related to CERs, in model (2), inter is significantly positive ($p < 0.1$), which supports Hypothesis1. Second, the result showa in Model (3) addresses the interaction effects of digital transformation and internationalization on CERs. The interaction effect of digital transformation and internationalization on CERs ($p < 0.05$) is negative, which supports Hypothesis2. Third, as showed in Table2 model (4), the interaction term coefficient between environmental regulation and internationalization is both significant and negative ($p < 0.01$), which supports the Hypothesis3.

The interaction effects are plotted to visually interpret the results. **Figure2** and **Figure3** show a more positive slope which illustrates our hypothesis.

Table2. Results of regression analysis

	(1) CERs	(2) CERs	(3) CERs	(4) CERs
Inter		0.387*	0.689**	0.797**
		(1.9)	(2.5)	(2.7)
Digital			0.139*	
			(1.9)	
Inter*Digital			-0.317**	
			(-3.0)	
Regulation				100.865***
				(4.1)
Inter* Regulation				-188.962**
				(-2.9)
_cons	-1.008	0.640	0.313	0.668
	(-0.2)	(0.1)	(0.1)	(0.1)
Control variables	yes	yes	yes	yes
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
N	1110.000	1110.000	1110.000	1110.000
F	1436.826	230.225	232.202	87.879

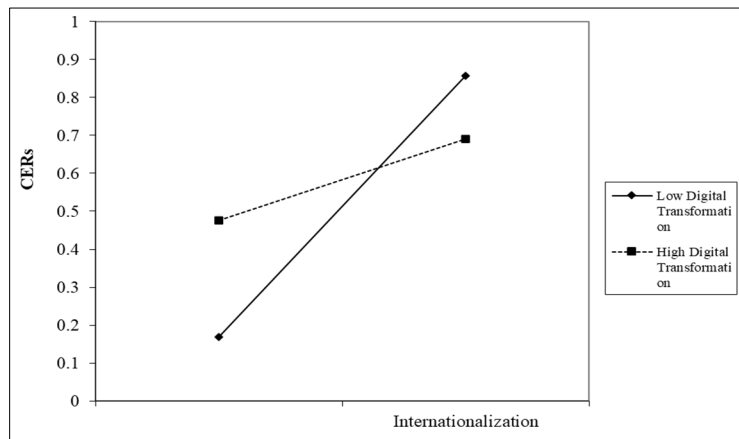


Fig.2. Two-way interactive effect of internationalization and digital transformation on CERs

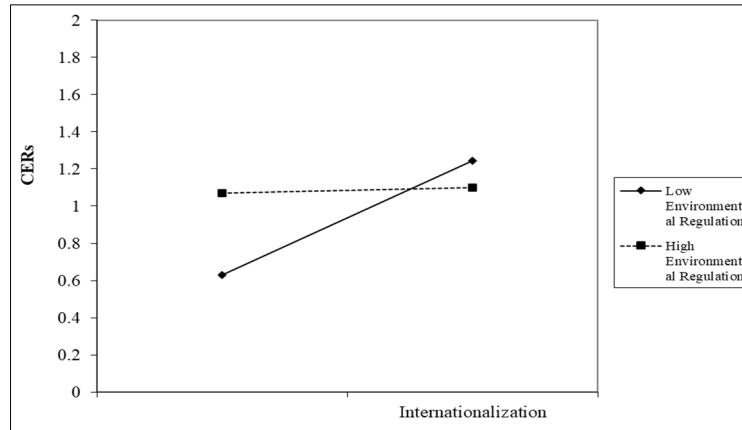


Fig.3. Two-way interactive effect of internationalization and environmental regulation on CERs

4.3 Robustness analysis

To bolster the robustness of our study findings, a robustness test was conducted in this study by altering the measurement approach for the core variable. In this case, we replaced the method of measuring internationalization by employing a natural log transformation of the number of foreign subsidiaries (Company) ^[30]. The regression results replicate our initial testing. Specifically, internationalization is significantly and positively related to CERs ($p < 0.1$), confirming Hypothesis 1 in the robustness testing. Moreover, the negatively significant effect of the two-way interaction term between internationalization and digital transformation ($p < 0.05$) supports Hypothesis 2. Additionally, the two-way interaction term of internationalization and environmental regulation also demonstrates a negatively significant effect ($p < 0.05$). In summary, the regression results presented in **Table 3** affirm the robustness of our findings.

Table3. Results of robust analysis

	(1) CERs	(2) CERs	(3) CERs	(4) CERs
Company		0.271*	0.483**	0.559**
Digital		(1.9)	0.139*	(2.7)
Company * Digital			(1.9)	
Regulation			-0.222**	100.865***
Company * Regulation			(-3.0)	(4.1)
				-132.570**
_cons	-1.008	0.640	0.313	0.668
	(-0.2)	(0.1)	(0.1)	(0.1)
Control variables	yes	yes	yes	yes
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
N	1110.000	1110.000	1110.000	1110.000

	(1) CERs	(2) CERs	(3) CERs	(4) CERs
F	1436.826	230.225	232.202	87.879

5 Discussion and Conclusions

5.1 Conclusions

This paper verifies the relationship between internationalization and CERs under the moderating effects of digital transformation and environmental regulation. It is interesting that we found digital transformation level will migrate the positive relationship between internationalization and CERs while environmental regulation will also migrate the positive effect of internationalization on CERs. Theoretically, this paper contributes to the literature in three ways.

First, differing from previous studies on internationalization and CSR, we explore the impact of internationalization on CERs differing from previous studies, which enriching the contributions of the influence of internationalization on CSR. Our study confirms that the internationalization is positively related to CERs.

Second, the bulk of environmental responsibility research has concentrated on larger corporations, neglecting the exploration of SMEs^[31]. Chen et al. (2022)^[32] used the panel data of SMEs in China to conduct research. And heavily polluting enterprises as a kind of enterprises which have a most influence by green policies^[33], was acceptance of greater pressure^[34]. So this paper, based on heavily polluted SMEs in China, demonstrates that internationalization facilitates CERs.

Third, this paper introduces digital transformation to explain the relationship among internationalization and CERs in the context of digitization. The results show that high level of digital transformation have a negative impact on the internationalization and CERs, which is consistent with previous findings of^[10]. Helping enterprises better understand and utilize digital technology, transforming the direction and efficiency of digital transformation.

5.2 Practical implications

This report offers helpful suggestions for SMEs that pollute significantly, which helps them better engage in digital transformation. This study investigates the impact of varying levels of digital transformation on the connection between CERs and internationalisation., and the findings suggest that high level of digital transformation migrate CERs in the internationalization process, that may because the firms invest to much resource in digital transformation, thus have difficult in fulfilling CERs. Therefore, companies should allocate resources reasonably, not only pursuing high-level digital transformation, but also choosing the parts that one needs, (i.e., big data, cloud computing, blockchain, artificial intelligence, and digital technology applications) to increase the effectiveness of digital transformation in meeting CERs during the internationalisation process.

At the same time, environmental regulations are more restrictive for heavily polluting SMEs, enterprises should vigorously develop green computer science research and make greater use of computer science and technology to process environmental data and help enterprises better adapt to environmental regulations, which can help to enhance the better use of computer

science and digital technology by enterprises to improve their internationalization and fulfillment of CERs during the internationalization under the context of digitalization.

5.3 Limitation and future research

The present investigation is not without limits. While the sample of heavily polluting SMEs in China offers a distinctive study setting, digital transformation also takes varied forms in other industries. In order to improve knowledge of organisational digital transformation, future study might begin from a wider research viewpoint and undertake cross-national and cross-cultural studies by gathering data from a bigger region. However, CERs are only one component of CER; future research might examine how internationalisation affects other CER components.

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