Enterprise Environment, Social, Government, Digital Transformation, and Enterprise Performance - Examining the Moderating Effect of Digital Transformation

Siyi Zheng[1*]

School of Economics and Management, Shihezi University, Shihezi, China

Abstract. In the paper, the connection between enterprise performance, digital transformation, and ESG performance is discussed where the impact of digital transformation in regulation is pointed out. Through theoretical analysis, ESG practice may impact enterprise performance due to increasing investment costs, while digital transformation is able to change the enterprise operation mode and improve efficiency. The study uses the Hausman test for empirical analysis. The results suggest negative relationships between ESG and enterprise performance, and this kind of correlation could be explained with the increase in the cost of investment at the beginning of ESG practice. In the meantime, its regulatory aspect in digital transformation also does not reveal any significance, and this fact can be either indicative of the infantile state of digital transformation in the formation of its impact in the context of the study under consideration, or of the intricacy of the nature of digital transformation impact upon the processes of the business and its efficiency in the allocation of the resources. This conclusion gives a new outlook of the enterprise to advertise the ESG strategy and digitization of business and also indicates the trend of further research in future related studies.

1 Introduction

Nowadays, ESG has become a hot topic in the development of enterprises. Environmental issues like global warming, rising sea levels, high carbon emission levels, and poor weather have become more current than in the past and all this point at the need to have green environmental protection and sustainable development and it is also the aspect that is not being overlooked in the development of any enterprise. As mentioned in many previous literature, good Environment, Social, Government (ESG) performance can improve enterprise value [1], promote enterprise innovation [2], alleviate financing constraints [3], improve enterprise investment efficiency [4], etc., but there is also literature that shows that good ESG performance requires long-term and high-intensity investment, which may reduce enterprise performance in the short term [5]. Using different methodologies of carrying out

*Corresponding author: 20231016032@stu.shzu.edu.cn

the research studies, different academics affirm the existence of a perception between ESG and corporate performance and draw different conclusions. At the same time, the level of digitalization of business administration has also acquired the role of a powerful factor in the development of enterprise performance with similar enthusiasm with the advent of the era of big data and artificial intelligence. The enterprise can also optimize the distribution of resources embracing the process of ESG, and the efficiency of enterprise operations, so that the cost of ESG also decreases, and the feasibility of ESG improves [6]. ESG is becoming significantly important as the current concept of environmental protection is deeply embedded in the hearts of the masses. Little academic literature on how digital transformation impacts ESG performance and enterprise performance especially in the form of case studies concerning the specific industries are available and are characterized by a low-level analysis and less structured. With this regard, this research aims at studying the energy sector and investigating the impact of digital transformation within ESG and corporate performance through analysis of Hausman test and regression test.

2 Theoretical analysis and research assumptions

2.1 Formatting the title, authors and affiliations Corporate ESG performance and corporate performance

The company will continue to grow and improve its performance through the efforts of all stakeholders as proposed by the stakeholder theory and businesses must work on performing the due responsibilities of the ESG. This can not only shape a good corporate image, but also help enterprises build a harmonious social network, attract outstanding talents, inject vitality into enterprise innovation, enhance competitiveness, and then promote enterprise performance [7].

It is the assumption of sustainable development theory that the healthy growth of the enterprises is bound tightly with the long-term performance of the enterprises, and that the performance of the enterprises in the sustainable growth can serve as a rather significant expression of this capacity of the enterprises. Enterprises focusing on ESG pay more attention to compliance and sustainability in their operations, which can effectively avoid short-sighted behavior and reduce potential risks, thus promoting performance improvement [8].

The use of the ESG performance of an enterprise as an alternative to giving of positive information to the external world becomes an emphasis of the signaling theory and proves to the outside world that an enterprise is responsible on both sides of environmental protection, social responsibility and good governance. The ESG ratings given by third party institutions to businesses attract higher reputation and exposure on the media, which forms an advertising effect [9,10]. Not only it could improve the social image of enterprises, but also could effectively mitigate the effect that information asymmetry has on the market and indirectly improve enterprise performance [11].

However, numerous scholars argue that enhancing ESG is a long-term investment endeavor, with direct economic benefits often elusive in the short term. In a sample of 405 industrial enterprises, Wang Shuangjin (2020) found out that the correlation between ESG responsibility performance and corporate financial performance was non-linear and resembled a "U-shaped" relationship [12]. Early theories argued that corporate social responsibility was a proxy problem, with managers mistakenly distributing shareholder wealth to pursue the social mission they chose. Because managers' pursuit of their desired social mission reduces the company's ability to maximize shareholder wealth, ESG is considered to be negatively correlated with corporate financial performance [13]. In the early stages of ESG practice, airlines showed a downward trend in financial performance.

Nonetheless, as some time elapsed since the implementation of ESG, the financial performance of enterprises grew slowly [14]. According to the presented above literature, hypotheses that are presented in this study are:

H1a: Enterprise performance is positively linked to ESG performance of enterprises.

H1b: Performance of enterprises which are measured using ESG has an inverse relationship with the performance of the enterprise itself.

2.2 The regulatory role of digital transformation

From the perspective of dynamic capability theory, digital transformation can strengthen the adaptability of enterprises to complex competitive environment. According to Smith&Wang, digital transformation has significantly improved the perception ability of enterprises with the help of real-time data and predictive analysis [15]. Enterprises can more accurately and quickly identify market changes and consumer needs, and seize development opportunities; By the profound use of digital technology, the enterprises can then get to optimize the production processes and subsequently, the operating expenses and the efficiency of the production are refined. Meanwhile, the task of governance of the enterprise environment (ESG responsibility) to achieve the benefits of energy conservation and emission reduction and other fundamental dimensions can accelerate environmental governance with the assistance of digital transformation so that digital transformation can contribute greatly to the advancement of ESG performance to promote the performance of the enterprise [16]. Due to the profound development of digital transformation, enterprises are capable of implementing sustainable development information integration, Completely gove oneself on the performance of ESG responsibility and the disclosure thereof, eliminate the adverse selection and moral hazard due to information asymmetry, internalized the social responsibility, and ultimately have a positive influence of the digital change to ESG responsibility performance on the performance of the enterprise [17].

Shanghangbiao et al. Chose the sample of the A-share listed company in the period of 2007 to 2021 and discovered that the difference of digital transformation affected the corporate performance in an inverted "U" relation, which is, in the first stage, prohibited and in the second stage, encouraged. [18]. From the perspective of enterprise innovation performance, Zhou Qing and others found that most dimensions of digital level and enterprise performance showed an inverted "U" relationship of first suppression and then promotion [19]. Ma Jun and Guo Mingjie also support this view, believing that there is a painful period of enterprise digital transformation [20].

In this respect, such assumptions are proposed by this study:

H2a: the digitalization of the enterprise as such also has an important regulating place between the ESG rating of the enterprise and the performance of the enterprise.

H2b: the fact that the enterprise is digitalized cannot be a high regulator between the ESG rating of the enterprise and the performance of the enterprise.

3 Research design

3.1 Data sources

Paper: As an object of research, the paper will choose listed companies of the energy industry in 2021-2023. The enterprise ESG performance and enterprise performance data applied in the present paper are based on the Wind database, and the digital transformation index of the firm is based on CSMAR database. This paper will use Stata for empirical research and

analysis, and use Excel to pre-process the selected data: (1) remove st and * ST samples from the samples; (2) Samples with severely missing data were excluded.

3.2 Variable selection

Table 1 shows the variable selection.

Table 1. Variable selection

Variable type	Variable	Variable Definition
Explained Variable	ROA	Net profit/average total assets
Explanatory variable	Corporate ESG performance	Following the approach of Wang Bo and Yang Maojia [1], the nine point method is used to assign scores to each level, that is, C=1, CC=2... and so on, in order to calculate the final score for the year.
Adjusting variables	Digital Transformation Index	Refer to the research of scholars such as Zhen Hongxian. After standardizing the indicators, the digital transformation index=strategic leadership score * 34.72%+technology driven score * 16.20%+organizational empowerment score * 9.69%+digital achievement score * 27.13%+digital application score * 8.84%+environmental support score * 3.42% [21]
Control variable	Enterprise scale (size)	Natural logarithm of annual total assets
	Shareholder equity ratio	Shareholder equity to total assets ratio
	Non current assets/total assets	Non current assets as a percentage of total assets
	Tangible assets/total assets	Ratios of tangible assets over total assets

3.3 Model setting

The statistical technique in the study to select random or fixed effect model was Hausman test. Hausman test results are as shown in Table 2.

Table 2. Hausman test results

	fe	re	Difference	Std. err.
ESG	-1.3009	-0.8943	-0.4065	0.3738
DIG	-0.0657	-0.0652	-0.0005	0.1174
size	7.89e-12	5.70e-12	2.18e-12	1.15e-11
shareholders' equity ratio	0.2025	0.2476	-0.0451	0.1351
Non-current assets / Total assets	0	0	0	0.0733
Tangible assets/Total assets	0	0	0	0.1494
chi2(5)	25.80			
P	0.0001			

Hausman test was employed in the comparison between the random effect model (RE) and the fixed effect model (FE). The test results showed that chi squared (5)=25.80, P value 0.0001, significantly rejected the original hypothesis (that is, the re model is more applicable), indicating that the fixed effect model can better capture individual unobservable heterogeneity and is suitable for panel data analysis in this paper. Therefore, the follow-up regression analysis is based on the fixed effect model.

According to the research topic of this paper and results of Hausman test following model is developed in the present paper:

$$ROA_{it} = \beta_0 + \beta_1 ESG_{it} + \beta_2 Z_{it} + u_i + \mu_i + \varepsilon_{it} \quad (1)$$

Of them, ROAit infrastructure reflects the profitability of enterprise i in period t, ESGit reflects the environmental information disclosure index of enterprise i in period t, Zit reflects the size of the enterprise, the asset liability ratio, the shareholder equity ratio, the ratio of non current assets to total assets and the ratio of tangible assets to total assets, which are random interferences.

4 Analysis of empirical results

4.1 Descriptive statistical analysis

Table 3. Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
ESG	219	3.9132	0.9658	1	6
DIG	219	30.9057	5.9787	21.2142	49.7743
ROA	219	6.0454	7.3332	-16.2052	34.1419
size	219	65468060495	206495852649.53	1539341797	1656988334410.36
lev	219	51.2277	17.7182	5.4761	98.1108
shareholders' equity ratio	219	48.7722	17.7182	1.8891	94.5239
Non-current assets / Total assets	219	57.1927	20.5191	3.43	95.3654
Current assets/Total assets	219	42.8073	20.5191	4.6346	96.57
Tangible assets/Total assets	219	34.2084	21.36527	-27.9403	86.7095

In the current research, the descriptive statistics of variables analyzed the final data of the sample. ESG (environmental, social and Governance) score: ESG score of the enterprises in the sample was between 1 and 6 with the average being 3.913242 and the standard deviation being 0.9658186, which proves that there were certain disparities in the ESG performance; Dig (digital transformation) index: the average is 30.90568, the standard deviation is 5.978737, ranging from 21.2142 to 49.7743, showing the differences in digital transformation of enterprises; ROA (return on assets): It measures corporate profitability, and its average is equal to 6.045382 and its standard deviation is equal to 7.333249 and its lowest and higher are equal to -16.2052 and 34.1419, that is why the variance between the corporate profitability is quite great; Enterprise size: Here the difference is the total assets, the average is 65.5 billion, the standard deviation is 20.6 billion, and the difference of enterprise size is significant; Shareholder equity ratio: the average is 48.77223, and the standard deviation is 17.71825, indicating that there are differences in the capital structure of enterprises;

Proportion of non current assets to total assets: the average value is 57.19269, and the standard deviation is 20.51912, indicating the difference between long-term investment and operation capabilities of enterprises; Tangible assets as a proportion of total assets: the average is 34.20841, the standard deviation is 21.36527, ranging from - 27.9403 to 86.7095, indicating the difference in the asset structure of enterprises, as shown in Table 3.

4.2 Benchmark regression analysis

Table 4. Benchmark regression analysis

	ROA	ROA
	（1）	（2）
ESG1	-1.4494**	-1.2929*
	(0.7018)	(0.6805)
size		0.0000
		(0.0000)
lev		-0.2003
		(0.1531)
Shareholders' equity ratio		0.0000
		(.)
Non-current assets / Total assets		-0.2131***
		(0.0812)
Current assets/Total assets		0.0000
		(.)
Tangible assets/Total assets		0.0008
		(0.1627)
cons	11.7171***	32.9960**
	(2.7638)	(15.5609)
N	219	219
r2	0.0286	0.1615
chi2		

Model (1) takes into account only esg 1 variables and model (2) involves addition of control variables in a gradual manner. It can be seen that the effect of esg1 on ROA is negative in both models and significant at the 10% and 5%, and the greater the performance of ESG the lower the profitability level of enterprises. This may reflect that ESG activities increase the cost investment of enterprises in the short term, which hurts profitability. In terms of control variables, the proportion of noncurrent assets in total assets shows a significant negative correlation in the model, indicating that a higher proportion of fixed assets may reduce the capital liquidity of enterprises, thus affecting their profitability; Other control variables were not statistically significant, as shown in Table 4.

4.3 Regulatory effects

To further investigate whether the level of enterprise digitalization plays a regulatory role between ESG and enterprise performance, in this paper, interaction terms have been introduced and a regulatory model is built. In an attempt to minimize the effects of multicollinearity phenomenon, ESG and digital variables are standardised in the paper , and the interactive term z_interact=z_ESG1 x z_DIG is generated.

Table 5. Regulatory effect of enterprise digitalization level on ESG and enterprise performance

	ROA
z_ESG1	-1.2965*
	(0.6890)
z_DIG	-0.4081
	(0.9278)
z_interact	0.1190
	(0.5700)
size	0.0000
	(0.0000)
lev	-0.2052
	(0.1548)
Shareholders' equity ratio	0.0000
	(.)
Non-current assets / Total assets	-0.2075**
	(0.0832)
Current assets/Total assets	0.0000
	(.)
Tangible assets/Total assets	-0.0028
	(0.1642)
_cons	27.9612*
	(15.0334)
N	219
r2	0.1628
chi2	

The result of the regression (see model M1) indicated that the coefficient of interaction was 0.1190 and there was no relative significance between the two variables as can be depicted by the coefficient, as shown in Table 5. It indicates to you that as a current sample, enterprise digitalization level has not as yet demonstrated a considerable regulatory impact on the effect of ESG on profitability.

5 Conclusion

This paper dwells on the connection between the ESG performance of enterprises, enterprise performance, and digital transformation. An empirical analysis reveals that enterprise ESG performance is negatively correlated with enterprise performance (H1B is established),

which also means that at the present stage, enterprises still face potential issues in the process of developing ESG performance, such as rising costs and rising complexity of management of operations, which will damage their performance. It may be because ESG practice requires enterprises to invest a lot of resources, such as upgrading environmental protection technology, carrying out social responsibility projects, and optimizing corporate governance structure, which are difficult to fully translate into economic benefits in the short term.

In addition, regulatory effect in the regulatory effect model which combines the interaction terms shows that the effect of digital transformation in enterprises on the relationship between ESG and enterprises performance is not significant (H2B is not established). It means that the negative relationship between ESG and corporate performance is not affected severely by digital transformation in the current sample. The potential reason could be the fact that the digitalization of a part of business is at the initial level, and its efficacy has not been fully realized yet, which is why the synergistic effect on ESG practice and the performance of enterprises cannot be substantial; On the other hand, there may still be obstacles for enterprises to promote the synergy between digital transformation and ESG practice, resulting in the failure to effectively show the synergy between the two.

At the enterprise level, ESG practice should be continuously optimized to enhance sustainable competitiveness in the long run by improving energy efficiency and strengthening communication with stakeholders. At the same time, need to actively seek opportunities for innovation and efficiency improvement in ESG projects to achieve win-win economic and social benefits. Given digital transformation, enterprises should formulate differentiation strategies according to their own ESG performance. Those with excellent performance should deepen the transformation, use digital technologies such as big data to accurately locate the market and artificial intelligence to optimize production, magnify ESG advantages and jointly enhance economic and environmental benefits; The performers who are lacking must pay more attention to strengthening the foundation of ESG, and proactively seek a synthesis point with ESG practice during the digital transformation process. From the perspective of policy measures, policymakers need to launch and firmly execute guiding incentive policies (namely tax incentives and special subsidies), aimed at urging enterprises with poor performances in terms of ESG to use digital technology in ESG practices (namely green technology innovation and environmental management system construction), effectively decreasing the transformation costs and increasing their motivation of participation.

References

1. B. Wang, M. Yang, Research on the impact mechanism of ESG performance on corporate value: Empirical evidence from A-share listed companies in China. Soft Sci. **36**, 78-84 (2022)
2. J. Li, Z. Yang, J. Chen et al, Research on the mechanism of ESG promoting corporate performance: Based on the perspective of corporate innovation. Sci. Technol. Manag. **42**, 71-89 (2021)
3. L. Chen, H. Yu, ESG performance, financing constraints, and corporate performance. Friends Account. **22**, 24-30 (2022)
4. J. Gao, D. Chu, Y. Lian et al, Can ESG performance improve corporate investment efficiency?. Secur. Mark. Her. **11**, 24-34 (2021)
5. S. Remmer, A.-K. H., I. H., Impact of ESG factors on firm risk in Europe. J. Bus. Econ. **86**, 867-904 (2016)
6. Y. Zhang, C. Yi, Enterprise digital transformation, green innovation, and ESG performance. Stat. Decis. **8**, (2025)

7. M. Meng, Q. Tao, L. Lei et al, Corporate social responsibility and corporate growth: The mediating effect of technological innovation. R&D Manag. **31**, 27-37 (2019)
8. E. Dimson, O. Karakaş, X. Li, Active ownership. Rev. Financ. Stud. **28**, 3225-3268 (2015)
9. Y. Yuan, X. Xiong, Research on the relationship between ESG performance and corporate performance of listed companies: The moderating effect based on media attention. Jiangxi Soc. Sci. **41**, 68-77 (2021)
10. L. Xi, H. Zhao, The mechanism and data verification of the impact of corporate ESG performance on earnings sustainability. Manag. Rev. **34**, 313-326 (2022)
11. A. Zhu, H. Wei, The relationship between ESG performance and corporate performance: A study on the moderation effect based on digital transformation. Friends Account. **2**, 44-52 (2024)
12. S. Wang, Y. Tian, L. Party, ESG responsibility fulfillment, competitive strategy, and financial performance of industrial enterprises. Account. Res. **3**, 77-92 (2022)
13. M. Friedman, The social responsibility of business is to increase its profits. N. Y. Times Mag. 13 September, 122-126 (1970)
14. T.C. Kuo, H.M. Chen, H.M. Meng, Do corporate social responsibility practices improve financial performance? A case study of airline companies. J. Clean. Prod. **310**, (2021)
15. J. Smith, Y. Wang, Dynamic capabilities and digital transformation: Evidence from Chinese firms. J. Strateg. Inf. Syst. **30**, 123-138 (2021)
16. X. Wu, M. Yang, Can fulfilling ESG responsibilities enhance corporate value creation? - Threshold effect based on digital transformation (2024)
17. H. Shang, T. Wu, Enterprise digital transformation, social responsibility, and enterprise value. Technol. Econ. **41**, 159-168 (2022)
18. H. Shang, J. Liu, Z. Wang et al, Research on the impact of digital transformation differentiation on enterprise performance. J. Manag. **21**, 193-201 (2024)
19. Q. Zhou, Y. Wang, W. Yang, Empirical study on the impact of digitization level on innovation performance: Based on panel data from 73 counties (districts, cities) in Zhejiang province. Res. Manag. **41**, 120-129 (2020)
20. J. Ma, M. Guo, Enterprise digital transformation, employee digital cognition, and innovation performance: Technology is the knife, I am the fish?. Technol. Prog. Countermeas. **40**, 22-32 (2023)
21. H. Zhen, X. Wang, H. Fang, Administrative protection of intellectual property and digital transformation of enterprises. Econ. Res. **58**, 62-79 (2023)