# The mechanism of action of digital transformation on corporate ESG performance: Evidence from China

Jie Sun

East China University of Science and Technology, Shanghai, China

Princekinlove@163.com

**Abstract.** Digital transformation has become a crucial trend for enterprises, and the ESG concept has gained increasing attention. However, existing research lacks in-depth separate studies on the impact of digital transformation on the E, S, and G dimensions respectively of enterprise ESG performance. This study presents new evidence of the effects of digital transformation on enterprise ESG performance by applying the panel fixed-effects model and overcomes the problem of research perspectives on ESG. Based on the data of Chinese listed companies from 1990 to 2023, the empirical results show the following: (1)Digital transformation positively promotes enterprise ESG performance, with significant improvements in the environmental and social dimensions and a slight decline in the governance dimension. (2)Digital transformation has a more significant positive impact on the ESG performance of large-scale and high-R&D-investment enterprises. (3)Financial leverage, cost-rate, and ROTA play different roles in the impact of digital transformation on ESG performance. In view of the research findings, it is advisable that enterprises make rational use of digital technologies and optimize their financial structures. Additionally, policymakers are expected to provide support for small and medium-sized enterprises and play a guiding role in promoting industry-wide development.

**Keywords:** Digital transformation; Enterprise ESG performance; Panel fixed-effects model.

## 1. Introduction

Digital transformation has become an important trend in enterprise development. At the same time, with the development of the global economy and society, ESG concepts have been increasingly valued, and the degree of its development has been deepening globally(Yang et al., 2024). Various regions and enterprises are actively practicing ESG concepts, but there is still an imbalance in the development of different industries and regions.

How will digital transformation affect an organization's ESG performance in terms of financial leverage, cost-rate or ROTA? Digital transformation refers to the profound and comprehensive integration of digital technologies into all aspects of an enterprise's operations, business models, and organizational structures, leading to fundamental changes in how an enterprise's operations, business models, and organizational structures are managed, leading to fundamental changes in how the enterprise creates value, interacts with stakeholders, and responds to market dynamics.

ESG stands for environmental, social and corporate governance. Environmental standards consider an enterprise's impact on the natural environment, such as carbon emissions; social factors cover an enterprise's relationship with its employees, customers, suppliers, and the communities in which it operates, including labour practices, human rights, and product safety; and corporate governance relates to an enterprise's leadership and control systems, including the board of directors. And when an enterprise has good ESG performance, it can also have a positive impact on that enterprise's digital transformation.

Previous papers on the impact of digital transformation on corporate ESG have three main directions, namely (1) research on the overall impact of digital transformation on corporate ESG; (2) research on the mediating mechanism of digital transformation affecting corporate ESG; and (3) research on the relationship between digital transformation and corporate ESG in different contexts(Su et al., 2023), but they all have certain limitations. In the first research direction, the existing papers mostly use empirical analysis to construct multiple linear regression models to quantify the relationship between digital transformation and the overall performance of corporate

ESG (Schaltegger et al.,2017), which treats ESG as a holistic concept and does not analyse the influence mechanism of each of the three dimensions of E, S, and G, making it difficult to give targeted enhancement strategies. Mediating mechanism research focuses on exploring mediating variables to explore the intrinsic influence path (Bocken et al.,2016), but the selection and measurement of mediating variables are subjective, and the research focuses on a single or a few variables, and is prone to ignore other important indirect factors, resulting in a lack of consistency and comparability of the results. Although external and internal contextual factors are introduced to explore the differences in impact (Amit et al.,2012), the interaction of multiple contextual factors is not fully considered and the conclusions lack generalisability.

Most of the existing studies conclude that the benefits of digital transformation outweigh the disadvantages for enterprise development. However some point out the possible problems of digital transformation: on the one hand, it may lead to uneven development between SMEs and large enterprises, or even further widen the development gap (Bharadwaj et al.,2013); on the other hand, if enterprises rely too much on technological solutions in the process of transformation, it may lead to information overload or misallocation of resources, which may weaken the actual effectiveness of ESG(Xiao et al., 2024).

This paper presents new evidence of the positive effect of digital transformation on enterprise ESG performance: while other studies generally agree that digital transformation contributes positively to firms' ESG performance, some still consider the effect to be negative, and this paper provides further evidence of the positive effect of digital transformation through the panel fixed-effects modelling approach and addresses the shortcomings of previous studies.

This study delves into the three specific dimensions of ESG, namely E, S and G to investigate the unique impact mechanisms, paths of action, and key drivers of digital transformation in each dimension respectively, instead of just stopping at the overall correlation of the study.

## 2. Hypothesis

The digital transformation of enterprises can improve information transparency and data management, achieve accurate monitoring and disclosure of environmental, social and corporate governance-related information with the help of digital technology, and respond to ESG risks in advance. From the perspective of each dimension, digital transformation can help accurately control environmental indicators and optimize resource utilization in the environmental dimension, promote interaction with stakeholders and generate responsible products in the social dimension, but may face greater internal change challenges in the governance dimension (Schaltegger et al.,2017). Overall, digital transformation positively contributes to corporate ESG performance and is more effective in the environmental and social dimensions than in the governance dimension. Therefore, we propose Hypothesis 1:

**Hypothesis 1: Digital transformation positively contributes to firms' ESG performance, more so in the environmental** and **social dimensions than in the governance dimension.**

Large enterprises are rich in capital, talent and other resources, so they can make large-scale investment in digital transformation, effectively integrate digital technology into their operations, and improve ESG performance in all aspects; small enterprises have limited resources, and due to the constraints of capital, technology, and experience, it is difficult for them to carry out digital transformation comprehensively, which has a limited effect on the improvement of ESG performance (Amit et al.,2012). Meanwhile, enterprises with high R&D investment have strong R&D capabilities and can use digital technology innovation in digital transformation, such as developing data analysis models to optimize supply chain sustainability and using digital technology to develop environmentally friendly products, etc., which can improve ESG performance more effectively; enterprises with low R&D investment have limited resources and can only adopt basic digital tools, making it difficult to give full play to the role of digital transformation in promoting ESG (Demirel et al.,2019). Therefore, Hypothesis 2 is proposed:

**Hypothesis 2: Compared with smaller/ low-R&D-investment firms, larger/ high-R&D-investment firms can get greater ESG** performance **by digital transformation.**

Enterprises with low financial leverage are in a strong financial position and are under less pressure to service their debt, allowing them to actively invest in digital transformation and improve their ESG performance. On the other hand, companies with high financial leverage are under pressure to service their debts, limiting their investment in digital transformation and favouring short-term debt servicing and cost-cutting, resulting in fewer resources for long-term environmental protection and governance enhancement projects, and negatively impacting overall ESG and governance performance(Han et al., 2024).Thus, we propose Hypothesis 3:

**Hypothesis 3: Firms with higher financial leverage have a more significant negative impact of digital** transformation **on their ESG performance.**

Cost-rate has a complex impact on corporate ESG performance. High cost-rate can limit companies' investment in environmental protection and corporate governance, harming overall ESG performance (Zhang & Huang, 2024). Therefore, we propose hypothesis 4:

Hypothesis **4: Firms with lower cost-rate have a positive effect of digital transformation on their ESG performance, and firms in this category also perform better on social and governance aspects.**

Enterprises with ROTA have strong profitability and sufficient funds to invest in digital transformation and ESG construction (Su et al., 2023). Therefore, we propose hypothesis 5:

Hypothesis **5: Firms with higher ROTA have a positive effect of digital transformation on their ESG performance.**

## 3. Methodology

### 3.1 Data

This study uses data from multiple data sources, whose sources include CSI, Wind, Huazheng and public data or annual reports of A-share listed companies, with data years from 1990-2023.

Table 1: Data Sources for ESG

| Category | Dimension | Index | Data Source | Coverage |
|---|---|---|---|---|
| ESG | Overall ESG | ESG Score | CSI, WindESG, Huazheng ESG rating | 1990-2023 |
| E | Environment | Environmental Indicators | | |
| S | Social | Social Indicators | | |
| G | Governance | Governance Indicators | | |

### 3.2 Variables

The dependent variable in this paper is the firm's ESG performance, measured by the indicator ESG, which, given the need to compensate for the lack of previous studies in ESG categorisation, is examined in four components: the overall ESG score as well as three separate components - environmental (E), social (S) and corporate governance (G). The independent variable is the firm's digital transformation, which is measured by the indicator Digital Transformation degree. Heterogeneity tests include firm size and the amount of firms' R&D investment.

### 3.3 Model

This paper adopts a panel fixed-effects regression model, which has significant advantages in analysing panel data and is particularly suited to the research context of this paper. On the one hand, it can effectively control the individual heterogeneity that does not change over time, avoiding the

estimation bias due to the omission of such variables and improving the accuracy of the results. On the other hand, it is effective in dealing with the endogeneity problem by controlling the individual fixed effects, alleviating the endogeneity problem arising from the omission of key variables, and making the estimation more reliable. Compared to the random effects model, it has better estimation consistency when individual effects are correlated with explanatory variables, which is more suitable for this study and the conclusions are more robust.Hence, the main basic empirical equation is a panel fixed - effect regression model.

$$ESG_{it} = \alpha_0 + \alpha_1 D_{it} + \beta X_{it} + year_t + v_i + \mu_{it} \quad (1)$$

where i and t represent company and time respectively; D represents digital transformation, X are the control variables;$year_t$ is the time fixed effect;$v_i$ is the individual effect; and is the residual. individual effect; and$\mu_{it}$ is the residual. Control variables include Enterprise age, currency ratio, total current assets and the Herfindahl Index, where the Herfindahl Index denotes the squared ratio of operating ratio.

## 4. Empirical analysis

### 4.1 Basic model

The table 2 below is the regression results of the basic model.

Table 2 Regression results of basic model

| | (1) Overall ESG score | (2) E score | (3) S score | (4) G score |
|---|---|---|---|---|
| Digital transformation | 0.004 *** | 0.008 *** | 0.009 *** | -0.003** |
| | (3.812) | (6.308) | (5.190) | (-2.259) |
| Enterprise age | -0.083 *** | 0.285 *** | 0.656 *** | -0.594*** |
| Currency ratio | 0.064 *** | 0.032** | -0.005 | 0.147 *** |
| Total current assets | 0.000 *** | 0.000 *** | 0.000 *** | 0.000 *** |
| Herfindahl index | 1.188 *** | 3.116 *** | 0.051 | 0.300 |
| Year effect | Y | Y | Y | Y |
| Individual effect | Y | Y | Y | Y |
| *N* | 25804 | 25804 | 25804 | 25804 |

*t* statistics in parentheses

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 2 shows that the digital transformation of Overall ESG is significant at the 1% level, and the absolute value is 0.004. This indicates that for every one-unit increase in the degree of digital transformation (the degree of digital transformation is measured as the natural logarithm of the sum of the This indicates that for every one - unit increase in the degree of digital transformation (the degree of digital transformation is measured as the natural logarithm of the sum of the total frequency of digital transformation characteristic words plus 1), the corporations' overall ESG score increases by 0.004 points. This proved part of Hypothesis 1, which states that the relationship between ESG and digital transformation is justified.

Furthermore, as demonstrated in Table 2, the digital transformation exerts a significant influence on E (Environment) and S (Society) at the 1% significance level, and on G (Governance) at the 5% significance level. This implies that with each one-unit increment in the degree of digital transformation, the digital transformation of E and S at the 1% significance level, and on G at the 5% significance level. The absolute values corresponding to E, S, and G are 0.008, 0.009, and 0.003. This implies that with each one-unit increment in the degree of digital transformation, the E score of corporations rises by 0.008 points, the S score ascends by 0.008 points, and the S score increases by 0.003 points. This implies that with each one-unit increment in the degree of digital transformation, the E score of corporations rises by 0.008 points, the S score ascends by 0.009 points, and the G score

declines by 0.003 points. These findings provide complete empirical support for Hypothesis 1, which posits that digital transformation is conducive to the environmental and social advancement of enterprises, yet it may impose a relatively mild adverse effect on corporate governance. effect on corporate governance

### 4.2 Subsample analysis

Firms of different sizes or R&D investment levels may respond differently to digital transformation in terms of ESG performance. Therefore, we categorise the sample into large/small scale firms and high/low R&D investment firms for the subsample heterogeneity test. Columns (1)-(4) in Table 3 correspond to small-scale firms, large-scale firms, low-R&D-investment firms, and high-R&D-investment firms, respectively.

Table 3 Regression results for large/small - scale enterprises and high/low R & D investment enterprises

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Small | Large | Low | High |
| Digital transformation | -0.002 | 0.009 *** | 0.001 | 0.008 *** |
| | (-1.196) | (5.352) | (0.800) | (4.400) |
| Enterprise age | -0.205 *** | -0.072 *** | -0.165 *** | 0.003 |
| Currency ratio | 0.060 *** | 0.019 | 0.066 *** | 0.020 |
| Total current assets | 0.000 *** | 0.000 *** | 0.000 *** | 0.000 *** |
| Herfindahl index | 1.335 *** | 0.371 | 0.526 | 0.136 |
| Year effect | Y | Y | Y | Y |
| Individual effect | Y | Y | Y | Y |
| *N* | 13485 | 12319 | 18429 | 7375 |

*t* statistics in parentheses

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Using the data on firms' total assets, we classify firm size by median. Table 3 shows that digital transformation significantly improves the overall ESG scores of large-scale firms at the 1% level (with a coefficient of 0.009), but has no significant effect on small-scale firms. Table 3 shows that digital transformation significantly improves the overall ESG scores of large-scale firms at the 1% level (with a coefficient of 0.009), but has no significant effect on small-scale firms. This may be due to the fact that large firms have abundant resources and well-developed management systems that allow them to invest more in digital transformation and integrate This may be due to the fact that large firms have abundant resources and well-developed management systems that allow them to invest more in digital transformation and integrate digital technologies into their operations, thus improving their ESG performance. Smaller firms, on the other hand, face resource and management constraints that reduce the return on digital transformation and ESG improvement.

Based on the R&D investment data, we divide firms evenly into high and low R&D investment groups with the average value of such investments. At the 1% level, digital transformation significantly improves the overall ESG scores of high R&D-investing firms (with a coefficient of 0.008), while it has no significant effect on low R&D-investing firms. High R&D-investing firms are more innovative and technologically capable, and they High R&D-investing firms are more innovative and technologically capable, and they improve their ESG performance by using digital technologies to produce green products, optimise management, and better fulfil their social responsibilities. On the other hand, firms with low R&D investment have limited technological and innovation capabilities, making it difficult for them to derive much benefit from the new technologies. On the other hand, firms with low R&D investment have limited technological and innovation capabilities, making it difficult for them to derive much benefit from digital transformation in terms of ESG. This confirms Hypothesis 2.

### 4.3 Robustness check

We replace the main variable-the overall ESG score-to conduct the robustness test. In the previous regression results, the data source of the overall ESG score of enterprises was the Wind database. In the previous regression results, the data source of the overall ESG score of enterprises was the Wind database. Next, we will use the average value of the overall ESG score from China Securities Index (CSI) ESG to perform the regression test. regression test.

Table 4 Robustness test results

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Overall ESG score | Small | Large | Low | High |
| Digital transformation | 0.001 *** (3.653) | -0.000 (-0.612) | 0.002 *** (5.545) | 0.000 (0.523) | 0.002 *** (4.209) |
| Enterprise age | -0.017*** | -0.043 *** | -0.013*** | -0.036 *** | 0.003 |
| Currency ratio | 0.010 *** | 0.007** | 0.004 | 0.009 *** | -0.005 |
| Total current assets | 0.000 *** | 0.000 *** | 0.000 *** | 0.000 *** | 0.000 *** |
| Herfindahl index | 0.227 *** | 0.241 *** | 0.115 | 0.119 | -0.017 |
| Year effect | Y | Y | Y | Y | Y |
| Individual effect | Y | Y | Y | Y | Y |
| *N* | 25902 | 13551 | 12351 | 18513 | 7389 |

*t* statistics in parentheses

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

As presented in Column (1) of Table 4, the digital transformation exerts a significant influence on the average value of the overall ESG score from CSI ESG at the 1% significance level, with an absolute value of 0.001. at the 1% significance level, with an absolute value of 0.001. Columns (2) and (3) demonstrate that the ESG performance of large-scale companies is Columns (2) and (3) demonstrate that the ESG performance of large-scale companies is significantly enhanced by digital transformation (significant at the 1% level, with an absolute value of 0.002), whereas small-scale companies do not experience a notable impact. Columns (4) and (5) reveal that companies with substantial investment in the R&D domain are positively influenced by digital transformation (significant at the 1% level, with an absolute value of 0.002), whereas small-scale companies do not experience a notable impact. digital transformation (significant at the 1% level, with an absolute value of 0.002), while those with meager R&D investment amounts remain unaffected. Notably, the magnitude and direction of the coefficient of the primary variable, namely the average value of the comprehensive ESG score from China Securities Index (CSI) Notably the magnitude and direction of the coefficient of the primary variable, namely the average value of the comprehensive ESG score from China Securities Index (CSI) ESG, exhibit minimal changes under this regression analysis. This strongly suggests the robustness of the previously drawn conclusions, thereby validating the consistency and reliability of the research findings.

## 5. Mechanism

The next challenge is identifying the paths through which digital transformation affects the ESG performance of enterprises. In the theoretical analysis, this paper argues that digital transformation may have a substantial impact on enterprise ESG performance through different mechanisms. analysis, this paper argues that digital transformation may have a substantial impact on enterprise ESG performance through different mechanisms. the model design, we incorporate the mechanism variables into the benchmark model to investigate whether the influence mechanisms are significant. specific model design is as follows.

$$ESG_i = \gamma_1(Moderator_{it} \times D_{it}) + \gamma_2 D_{it} + \gamma_3 Moderator_{it} + \beta X_{it} + year_t + v_i + \mu_{it} \quad (2)$$

Digital transformation empowers enterprises with advanced digital technologies, such as artificial intelligence, big data, and the Internet of Things, enabling them to optimise business processes, enhance decision-making efficiency, and improve resource utilisation. Things, enabling them to optimise business processes, enhance decision-making efficiency, and improve resource utilization. transformation can influence enterprise ESG performance through three channels: financial leverage (asset-liability ratio), cost-rate (ratio of operating cost to operating revenue), and cost-effectiveness (ratio of operating cost to operating revenue). We believe that digital transformation can influence enterprise ESG performance through three channels: financial leverage (asset-liability ratio), cost-rate (ratio of operating cost to operating revenue), and ROTA.

### 5.1 Financial leverage (asset-liability ratio)

Digital transformation may affect a company's financial leverage by influencing aspects such as investment demand, corporate profitability, or capital operation efficiency. In turn, this can impact the company's performance across different dimensions (E, S, G), thereby further enhancing its ESG performance. Therefore, we establish an interaction term, "Finance", which is obtained by multiplying the debt-to-asset ratio and digital transformation. transformation.

Table 5 The mechanism function of financial leverage

| | (1)<br>Overall ESG score | (2<br>E score | (3)<br>S score | (4)<br>G score |
|---|---|---|---|---|
| Digital transformation | 0.006 *** | 0.008 *** | 0.007 *** | 0.003* |
| Finance | -0.005*** | 0.002 | 0.004** | -0.014*** |
| | (-4.576) | (1.332) | (2.076) | (-8.669) |
| Covariates | Y | Y | Y | Y |
| Time effect | Y | Y | Y | Y |
| Individual effect | Y | Y | Y | Y |
| *N* | 25803 | 25803 | 25803 | 25803 |

*t* statistics in parentheses
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

According to the fixed effect model regression results in Table 5, gearing ratio does not have a significant effect on the environmental performance of firms. According to the fixed effect model regression results in Table 5, gearing ratio does not have a significant effect on the environmental performance of firms. However, at the 1% significance level, gearing has a significant negative effect on overall environmental, social and governance performance. For every 1% increase in gearing ratio, the firm's overall environmental, social and governance score decreases by 0.005 points and governance score For every 1% increase in gearing ratio, the firm's overall environmental, social and governance score decreases by 0.005 points and governance score decreases by 0.014 points. This is because high ratios imply heavy debt and financial constraints, causing firms to focus on short-term debt repayment and cost-cutting, which reduces the resources available for long-term ESG programmes.

In addition, gearing ratio at the 5% level has a significant effect on the firm's social score with a coefficient of 0.004, which implies that for every 1% increase in gearing ratio, the firm's social score increases by 0.004 points. In addition, gearing ratio at the 5% level has a significant effect on the firm's social score with a coefficient of 0.004, which implies that for every 1% increase in gearing ratio, the firm's social score increases by 0.004 points. When a firm's gearing ratio is high, the firm has more incentives to maintain When a firm's gearing ratio is high, the firm has more incentives to maintain good relationships with stakeholders such as employees and the community in order to obtain stable operations and support from creditors. For example, firms may invest more in employee welfare or community building activities, thus increasing the social score. This validates Hypothesis 3.

### 5.2 Cost-rate (ratio of operating cost to operating revenue)

Digital transformation can affect a company's cost-rate through operational and productivity efficiency and operating costs, which in turn affects its environmental, social and governance performance. Therefore, the interaction term "Cost" is derived by multiplying Therefore, the interaction term "Cost" is derived by multiplying cost ratio and digital transformation.

Table 6 The mechanism function of cost-ratio

| | (1) Overall ESG score | (2 E score | (3) S score | (4) G score |
|---|---|---|---|---|
| Digital transformation | 0.013 *** | 0.010 *** | 0.017 *** | 0.008** |
| Cost | -0.010*** | -0.002 | -0.008* | -0.012*** |
| | (-3.835) | (-0.531) | (-1.829) | (-3.214) |
| Covariates | Y | Y | Y | Y |
| Time effect | Y | Y | Y | Y |
| Individual effect | Y | Y | Y | Y |
| *N* | 25803 | 25803 | 25803 | 25803 |

*t* statistics in parentheses
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

From the fixed effects model regressions in Table 6, cost ratio has no significant effect on environmental performance. However, it has a significant negative effect on overall environmental, social and governance performance at the 1% level with coefficients of 0.010 and 0.012, respectively. negative effect on overall environmental, social and governance performance at the 1% level with coefficients of 0.010 and 0.012, respectively. every 1% increase in the cost ratio, the overall environmental, social and corporate governance scores decrease by 0.010 and the governance score by 0.012. 0.012. This is because a high cost-ratio limits investment in environmental protection and governance improvements, such as lack of funds for pollution control equipment upgrades or governance structure. This is because a high cost-ratio limits investment in environmental protection and governance improvements, such as lack of funds for pollution control equipment upgrades or governance structure optimisation.

Meanwhile, the effect of cost-ratio on social score is significant at 10% level with a relatively weak coefficient of 0.008. This is due to the fact that Despite the pressure of cost-ratio, companies still fulfil their social responsibilities for reasons such as corporate culture, brand building and industry. Despite the pressure of cost-ratio, companies still fulfil their social responsibilities for reasons such as corporate culture, brand building and industry norms. For example, some firms will continue to invest in employee welfare and community activities as far as they are able, hence the impact of cost ratio on social performance is limited. This proved Hypothesis 4.

### 5.3 Return on total assets

Digital Transformation can affect a company's ROTA through aspects such as business channels and product/service quality, thereby affecting its ESG performance. Thus, multiplying ROTA with digital transformation produces the interaction term "Assets". ".

Table 7 The mechanism function of ROTA

| | (1) Overall ESG score | (2 E score | (3) S score | (4) G score |
|---|---|---|---|---|
| Digital transformation | 0.004 *** | 0.008 *** | 0.009 *** | -0.003** |
| Assets | 0.013** | -0.005 | 0.007 | 0.030 *** |

| | | | | |
|---|---|---|---|---|
| | (2.549) | (-0.799) | (0.812) | (3.993) |
| Covariates | Y | Y | Y | Y |
| Time effect | Y | Y | Y | Y |
| Individual effect | Y | Y | Y | Y |
| *N* | 25803 | 25803 | 25803 | 25803 |

*t* statistics in parentheses
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

From the fixed effects model regressions in Table 7, ROTA has no significant effect on firms' ESG performance. However, it has a significant effect on overall ESG performance at the 5% level with a coefficient of 0013. However, it has a significant effect on overall ESG performance at the 5% level with a coefficient of 0.013. Each 1% increase in ROTA increases the overall ESG score by 0.013. This may be due to the fact that higher ROTA means higher corporate profits and more resources to invest. This may be due to the fact that higher ROTA means higher corporate profits and more resources to invest in environmental protection, social welfare and sustainable development. This may be due to the fact that higher ROTA means higher corporate profits and more resources to invest in environmental protection, social welfare and sustainable development.

In addition, ROTA has a significant effect on governance performance at the 1% level with a coefficient of 0.030. Every 1% increase in ROTA increases the governance score by 0.030 points. This may be due to the fact that good ROTA reflects effective governance. When firms operate efficiently and profitably, they are more likely to have a sound governance structure. When firms operate efficiently and profitably, they are more likely to have a sound governance structure. This gives management the incentive and resources to improve governance, such as strengthening internal controls and increasing transparency, thus increasing the governance score. This validates Hypothesis 5.

## 6. Conclusion and Discussion

This paper explores the impact of digital transformation on ESG performance of enterprises, and clearly reveals the complex connection between the two and the internal mechanism of the two by using a combination of theoretical analyses and empirical research methods. The results of this study show that there is a significant association between digital transformation and corporate ESG performance, which is differentiated in different dimensions and types of enterprises, and is affected by a combination of factors.

Hypothesis 1 proposes that digital transformation positively contributes to firms' ESG performance, and the improvement effect is more significant in the environmental and social dimensions than in the governance dimension. This is consistent with Bocken et al.(2016) that digitalisation drives corporate sustainability, but this paper further clarifies the differential impact across ESG dimensions. Based on this, enterprises should actively embrace the wave of digital transformation and continue to increase investment in the field of digital technology, and they should fully consider the characteristics of each dimension and formulate differentiated development strategies in the process of promoting digital transformation.

Hypothesis 2 suggests that large firms and firms with high R&D investment are more likely to achieve improved ESG performance when digitally transforming than small firms and firms with low R&D investment. It is supported by Amit and Zott (2012) that resource-rich firms are more advantageous in taking advantage of the transition to new technologies. Hence policy makers should pay great attention to the development needs of small enterprises and formulate and implement a series of targeted support policies. At the same time, firms themselves need to focus on R&D and innovation, and the government should further increase its support for R&D in order to promote the integration of digital technology and ESG practices.

Hypothesis 3 states that firms with higher financial leverage will experience a more significant negative impact of digital transformation on their ESG performance, but may boost their social performance. Goss and Roberts (2011) mentioned firms' financial status affects social responsibility performance. This study further reveals the different effects of financial leverage on ESG dimensions in digital transformation. Therefore, enterprises should reasonably control their financial leverage and optimize their financial structure to ensure their stable development in digital transformation, and the government should guide financial institutions to provide reasonable financing support.

Hypothesis 4 proposes that firms with lower cost-rate have a more significant effect of digital transformation on their ESG performance, and they perform better on the social and governance dimensions. Yang et al.(2024) and Zhang & Huang (2024) studied the link between cost and social responsibility of enterprises, which supports this hypothesis. Based on this, enterprises should strengthen cost management and combine digital technology with cost control; industry associations should also set standards to guide enterprises to control costs and promote the ESG level of the whole industry.

Hypothesis 5 suggests that firms with higher total asset margins have a more significant improvement in ESG performance from digital transformation and have better governance performance. Parida et al. (2021) thought enterprises with high profitability perform better in social responsibility and governance, which is consistent with the findings of this study. Enterprises should improve asset operation efficiency and optimize business processes to provide solid financial protection for digital transformation and ESG construction, while the government should give recognition to such enterprises to guide more enterprises to practice the concept of sustainable development.

In summary, digital transformation brings opportunities for enterprises to improve ESG performance, but different enterprises face different challenges. Enterprises should take into account their own characteristics and industry trends, and make use of digital technology to improve ESG performance. Future research could expand the perspective to explore the relationship between digital transformation and ESG performance of enterprises in different industries and regions, as well as the strategies to promote the synergistic development of the two. Meanwhile, there are limitations in this study, such as possible omission of control variables, endogeneity problem, and narrow sample scope. However, as an exploratory study, this study also provides a certain foundation for subsequent in-depth research.

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