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The impact of board digital cognition on the execution quality of corporate ESG strategy

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Abstract. Against the background of deep integration between digital transformation and Environmental, Social, and Governance (ESG), corporate ESG strategy no longer remains at the level of responsibility disclosure or image construction. It is gradually shifting toward target decomposition, resource allocation, process supervision, and performance improvement. As the core body of strategic decision-making and governance supervision, the board affects how firms understand ESG data, risk information, and execution processes through its level of digital cognition. Based on public disclosures of A-share non-financial listed companies from 2016 to 2023, the board digital cognition index can be constructed from directors' digital backgrounds, digital governance expressions, digital committee settings, and digital training disclosures. ESG strategy execution quality can be measured through target completion, quantitative disclosure, investment intensity, rating improvement, and penalty deductions. The baseline regression results show that board digital cognition has a significant positive effect on ESG strategy execution quality. The mechanism tests further show that internal control quality and digital investment strengthen this influence path. This finding indicates that board digital cognition not only reflects the upgrading of the governing body's knowledge structure, but also promotes the shift of ESG strategy from formal disclosure to substantive execution by improving information processing, supervisory constraints, and resource allocation.

Keywords: board digital cognition, ESG strategy, execution quality, corporate governance, digital transformation

1. Introduction

Digital transformation and ESG governance are jointly reshaping the logic of corporate strategy execution. ESG has gradually shifted from responsibility disclosure to operational embedding, requiring firms to integrate environmental goals, social responsibility, and governance standards into investment decisions, resource allocation, risk control, and performance assessment. As the core body of strategic decision-making and supervision, the board directly shapes how firms interpret institutional pressure and internal transformation needs. Upper echelons theory suggests that organizational strategy is influenced by top managers' cognitive bases and values [1]. In a context where digital technologies rapidly penetrate business operations, whether boards understand data governance, digital risk identification, and intelligent management becomes crucial for transforming ESG commitments into executable processes. Prior research has shown that

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corporate sustainability can improve organizational processes and long-term performance [2]. Yet the specific influence of board digital cognition on ESG strategy execution quality still requires more detailed examination. Based on public disclosures of A-share listed firms, an empirical framework can be developed through directors' digital backgrounds, digital governance expressions, ESG target completion, and execution inputs to examine the effect and governance mechanism of board digital cognition.

2. Literature review

2.1. Digital cognition foundation

Board digital cognition refers to the ability of corporate directors to understand digital technologies, data resources, and digital risks. Its core is not the number of digital tools a firm has adopted, but whether the governing body can incorporate digital logic into strategic judgment. Research on digital transformation shows that corporate digital change usually involves systematic adjustments in organizational structure, resource allocation, and strategic processes [3]. As a supervisory body, the board can better understand how digital technologies reshape operational boundaries and responsibility boundaries when directors have experience in information technology, data analytics, platform operations, or digital governance. Digital transformation also emphasizes cross-functional coordination and the reconstruction of dynamic capabilities, so board digital cognition may influence whether ESG issues are incorporated into data monitoring, risk warning, and strategic evaluation systems [4]. In this sense, digital cognition is not merely a personal background characteristic of directors; it is also an important component of corporate governance capability.

2.2. ESG strategy execution

The execution quality of ESG strategy concerns whether firms can transform sustainability goals into observable, measurable, and supervisable business actions. Existing research finds a relatively stable positive relationship between ESG and financial performance, suggesting that responsibility governance is not merely a cost burden but can create long-term value through risk reduction, reputation accumulation, and resource efficiency improvement [5]. Evaluation of execution quality should go beyond disclosure volume and further consider target setting, quantitative indicators, financial input, managerial responsibility, and performance improvement. Research on board diversity shows that governance structure affects the strength of corporate responses to sustainability issues and disclosure behavior [6]. Therefore, ESG execution is not only a managerial implementation issue; it is also shaped by board supervision and strategic cognition. When firms have clear targets, continuous investment, and consistent disclosure, ESG strategy is more likely to become stable organizational action.

2.3. Governance transmission mechanism

The influence of board digital cognition on ESG strategy execution quality depends on how cognitive advantages are converted into governance actions. Digital capability can improve the efficiency of processing environmental data, supply chain responsibility, compliance risks, and stakeholder feedback, moving ESG management from experience-based judgment to data-supported decision-making. The effect of digital transformation on ESG performance is often realized through green innovation, resource allocation efficiency, and organizational learning [7]. Boards that understand the managerial value of digital technologies are more likely to promote internal control system upgrades, ESG data platform construction, and cross-departmental responsibility coordination. Research on resource allocation efficiency also indicates that digital

transformation can reduce information asymmetry and improve the efficiency of strategic resource use [8]. In this process, internal control quality strengthens execution constraints, digital investment provides technical support, and disclosure standardization increases external supervisory pressure, jointly forming the governance pathway through which digital cognition improves ESG execution quality.

3. Experimental methods

3.1. Sample data source

The sample includes A-share non-financial listed companies from 2016 to 2023, excluding ST firms, financial firms, listing-year observations, samples with missing core disclosures, and observations with obvious abnormal values. All data are collected from publicly available sources. Board digital cognition is identified from annual reports, including directors' biographies, educational backgrounds, professional experience, board composition, special committee settings, and board meeting disclosures. ESG strategy execution data are obtained from annual reports, ESG reports, CSR reports, sustainability reports, stock exchange announcements, CNINFO, and corporate websites. The collected items include ESG target setting, quantitative disclosure, green investment projects, employee responsibility practices, governance improvements, ESG rating changes, and environmental penalty records. Financial and governance control variables, including firm size, profitability, leverage, revenue growth, board size, independent director proportion, and firm age, are collected from annual reports and public exchange disclosures. The data are matched by company code and year to form a firm-year panel dataset, with continuous variables winsorized at the 1% and 99% levels.

3.2. Variable measurement design

Board digital cognition is the core explanatory variable. Four dimensions are first extracted, including the proportion of directors with digital backgrounds, the frequency of digital governance keywords, the establishment of digital-related committees, and the disclosure of digital training [9]. These indicators are then standardized and combined into a composite index, as shown in Formula (1).

$$BDC_{it} = \sum_{k=1}^{4} \omega_k Z(X_{kit}) \tag{1}$$

In Formula (1), BDC_{it} represents the board digital cognition index of firm i in year t. X_{kit} represents the k_{th} type of digital cognition indicator. $Z(\cdot)$ represents standardized processing. ω_k represents the indicator weight.

ESG strategy execution quality is the dependent variable [10]. It is measured by target completion, quantitative disclosure, ESG investment intensity, rating improvement, and penalty deductions, as shown in Formula (2).

$$ESGExec_{it} = \sum_{m=1}^{4} \eta_m Z(Y_{mit}) - \eta_5 Z(Penalty_{it}) \tag{2}$$

In Formula (2), $ESGExec_{it}$ represents ESG strategy execution quality. Y_{mit} represents the mmmth type of positive execution indicator. $Penalty_{it}$ represents environmental, governance, or information disclosure penalties. η_m represents the weight.

The baseline regression adopts a two-way fixed effects model. Board digital cognition is lagged by one period, as shown in Formula (3).

$$ESGExec_{it} = \alpha + \beta BDC_{i,t-1} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{3}$$

In Formula (3), $Controls_{it}$ represents control variables such as firm size, profitability, asset-liability ratio, growth, board size, and proportion of independent directors. μ_i represents firm fixed effects. λ_t represents year fixed effects. ε_{it} represents the random error term.

3.3. Model testing process

The model testing follows the sequence of variable construction, baseline regression, mechanism testing, and robustness testing. First, descriptive statistics, correlation tests, and multicollinearity tests are conducted for the board digital cognition index and the ESG strategy execution quality index [11]. This step ensures that the core variables have reasonable distributions and that the variance inflation factor remains within an acceptable range. Second, a two-way fixed effects model is used to estimate the effect of board digital cognition on ESG strategy execution quality. Firm-level clustered robust standard errors are adopted to address heteroskedasticity and serial correlation. Third, internal control quality and digital investment are introduced as mechanism variables to examine whether board digital cognition improves ESG execution by strengthening process control and resource allocation. Finally, robustness tests are conducted by replacing the ESG strategy execution quality indicator, using a two-period lag of the core explanatory variable, excluding samples from special years, and applying propensity score matching. These procedures allow the results to correspond closely with the data sources, variable measurement, and model specification.

4. Results

4.1. Model testing process

The baseline regression results are reported by gradually adding control variables and fixed effects, as shown in Table 1. The illustrative results show that the regression coefficients of board digital cognition are positive in all four models. They are significant at the 5% or 1% level. In Model (1), where full control variables are not included, the coefficient is 0.083. After adding firm size, profitability, asset-liability ratio, and growth, the coefficient decreases to 0.071. After further controlling for firm and year fixed effects, the coefficient is 0.058. This result indicates that unobservable firm characteristics and macro-level annual shocks do not weaken the core relationship. In Model (4), after clustered robust standard errors are adopted, the coefficient remains at 0.061. The adjusted R^2 increases from 0.214 to 0.351. This means that the explanatory power of the model improves as the control structure becomes more complete. The result suggests that when board digital cognition increases by one standard deviation, ESG strategy execution quality increases by approximately 0.058 to 0.083 standard deviations. The effect size is moderate, yet it has clear managerial explanatory value.

Table 1. Baseline regression results of board digital cognition and ESG strategy execution quality

Variable	Model (1)	Model (2)	Model (3)	Model (4)
Board digital cognition	0.083***	0.071***	0.058**	0.061**
	(0.021)	(0.019)	(0.023)	(0.024)
Firm size	—	0.026**	0.019*	0.018*
Profitability	—	0.044***	0.036**	0.035**
Asset-liability ratio	—	-0.031**	-0.027*	-0.026*
Growth	—	0.022*	0.018*	0.017*
Firm fixed effects	No	No	Yes	Yes
Year fixed effects	No	Yes	Yes	Yes

Table 1. Continued

Clustered robust standard errors	No	No	No	Yes
Observations	12,486	12,486	12,486	12,486
Adjusted R^2	0.214	0.285	0.342	0.351

Note: Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

4.2. Extended verification evidence

The mechanism test further examines whether internal control quality and digital investment constitute transmission pathways. The illustrative results show that the coefficient of board digital cognition on internal control quality is 0.046. It is significant at the 5% level. The coefficient on digital investment is 0.052. It is significant at the 1% level. After the two mechanism variables are included at the same time, the coefficient of board digital cognition decreases from 0.061 to 0.044, while it remains significant. This indicates that its effect does not rely on a single pathway. Instead, it works through both governance process optimization and digital resource allocation. In the robustness tests, the coefficient is 0.056 after replacing the ESG strategy execution quality indicator. It is 0.049 after using a two-period lag. It is 0.053 after excluding the 2020 sample. The direction and significance remain consistent. As shown in Figure 1, when the board digital cognition index and digital investment intensity increase at the same time, the predicted value of ESG execution quality rises from approximately 0.42 to approximately 0.66. This indicates that digital cognition has a stronger execution conversion effect in a high-investment environment.

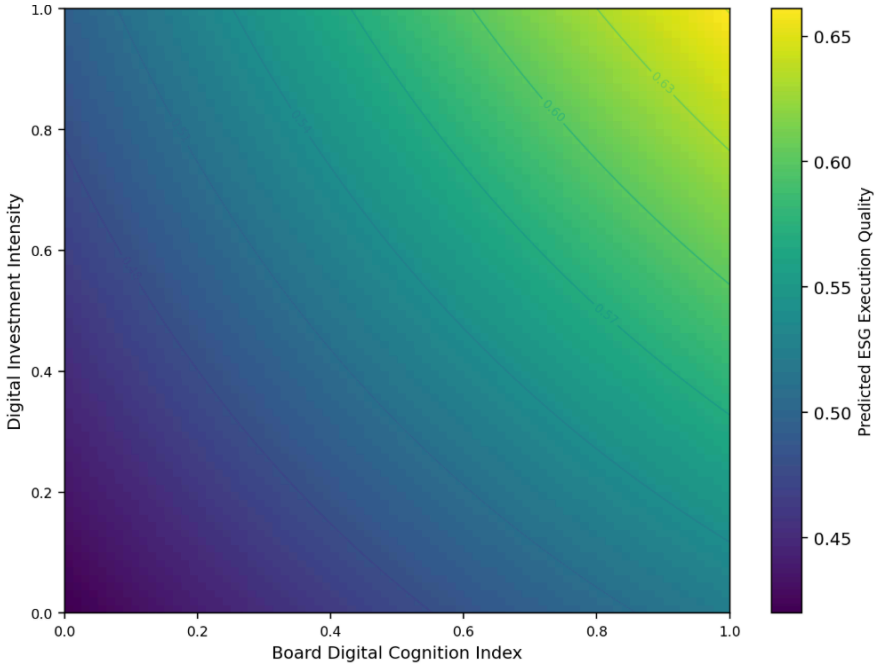

Figure 1. Joint marginal effect surface of board digital cognition and digital investment

5. Discussion

The regression results show that higher board digital cognition is associated with better ESG strategy execution quality. This indicates that digital cognition strengthens the board's ability to identify ESG targets, data indicators, and execution processes. The result is consistent with the logic of upper echelons theory, which argues that the cognitive structure of governing bodies affects corporate strategic behavior. Further evidence from the mechanism tests shows that internal control quality and digital investment play transmission roles. Digital cognition does not directly turn into ESG performance. It first affects management processes, information transparency, and resource allocation efficiency. Boards with stronger digital backgrounds are more likely to promote ESG data platforms, responsibility decomposition, and cross-departmental coordination. This reduces symbolic disclosure and execution deviation. In the robustness tests, the direction of the coefficients remains consistent, showing that the effect of board digital cognition on ESG execution is relatively stable.

6. Conclusion

Board digital cognition can improve the execution quality of corporate ESG strategy by optimizing information processing, strengthening internal control, and improving digital resource allocation. Based on public data from A-share non-financial listed companies, directors' digital backgrounds, digital governance expressions, and related governance arrangements can be used to measure board digital cognition. ESG target completion, quantitative disclosure, investment intensity, rating changes, and penalty records can be used to identify execution quality. The findings suggest that improving board digital capability helps promote ESG strategy from formal disclosure to substantive execution and provides reference for optimizing board structure and digital governance systems.

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