

The association between managerial short-termism and green innovation: the moderating role of firms' digital transformation

Managerial
short-termism
and green
innovation

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Abstract

Purpose – The purpose of this study is to examine the impact of managerial short-termism on green innovation of firms and the moderating role of digital transformation of enterprises in the association between managerial short-termism and green innovation.

Design/methodology/approach – This study uses data from Chinese A-share listed companies from 2001 to 2021 and employ panel fixed model and moderating effect model to examine the impact of managerial short-termism on green innovation of firms and the moderating role of digital transformation of enterprises in the association between managerial short-termism and green innovation.

Findings – The findings of this study reveal that managerial short-termism exerts negative influence on green innovation. Digital transformation enables firms to reduce the adverse effect of managerial short-termism on green innovation because digital transformation enhances information processing ability and then improves internal corporate governance and analyst coverage. Moreover, the moderating role of digital transformation is more prominent for firms with lower internal corporate governance, for firms with less analyst coverage and for non-state-owned enterprises.

Originality/value – This paper intends to address the following two questions: what is the impact of managerial short-termism on green innovation and what is the role of digital transformation in the two variables' association? By using data of Chinese A-share listed companies from 2001 to 2021 and developing two individual indexes to measure managerial short-termism and digital transformation, the authors empirically test these above two questions. The results of this study indicate that: First, drawn on time-oriented theory and upper echelon theory, managerial short-termism has an adverse effect on firms' green innovation. Second, digital transformation enables firms to reduce the negative effect of managerial short-termism on green innovation. Furthermore, the moderating mechanism tests show that the corporate governance effects of digital transformation play a supervisory role that impels managers to reduce short-term investments and promote firms' green R&D investments, which helps to reduce the negative effect of managerial short-termism on green innovation. Additionally, the heterogeneity checks show that the moderating role of digital transformation in the relation between managerial short-termism and green innovation is more prominent for firms with lower internal corporate governance, with less analyst coverage and for non-state-owned enterprises.

Keywords Green innovation, Managerial short-termism, Digital transformation

Paper type Research paper



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1. Introduction

In the quest for expeditious economic growth, nations have embraced economic approaches that are convenient, yet unfortunately detrimental to the environment. China serves as a notable example, wherein it has witnessed a remarkable trajectory of rapid economic growth after its implementation of reform and opening-up policies. However, this progress has been accompanied by significant environmental consequences. The scholarly literature extensively recognizes the significance of incorporating green innovation as a key driver in promoting sustainable development and facilitating a full transition toward environmentally friendly practices in the long run (Mensah *et al.*, 2018). Enterprises assume a pivotal position in facilitating the advancement of environmentally sustainable innovation. Government has introduced a diverse array of policies with the objective of motivating enterprises to embrace and integrate green technologies. However, despite the implementation of these policies, there is still a lack of adoption by some managers in acquiring green innovation (Holmstrom, 1989). The upper echelons theory emphasizes the importance of managers' behavior, suggesting that executives' personalities will influence the strategic decisions of companies (Hambrick, 2007). Executives, as key decision-makers within organizations, have the authority to shape the strategy for green innovation. The characteristics of executives can impact the level of involvement of enterprises in green innovation. In the field of green innovation, an important and intriguing personal characteristic to consider is managerial short-termism.

Managerial short-termism refers to the tendency of managers to have a short-term perspective and prioritize the present moment. The cognitive bias discussed by Stein (1989) and Lin *et al.* (2019) is characterized by managers' tendency to prioritize immediate outcomes while neglecting long-term issues. Managers with a myopic perspective tend to prioritize immediate gratification and short-term benefits. The concept of a short-term time orientation is commonly understood to be an inherent and enduring personal characteristic (Goldrich, 1967) and an unconscious cognitive process (Zimbardo and Boyd, 2014). In light of the aforementioned backdrop, it is crucial to undertake reflection and inquiry into the possible consequences of managerial short-termism on the progress of green innovation within firms. The core objective of this research is to explore the impact of management short-termism on the green innovation.

Meanwhile, managerial short-termism not only signifies the intricate interplay between the temporal perspectives of various stakeholders but also elucidates the intricate dynamics between managers and shareholders (Jackson and Petraki, 2011). Hence, within the framework of the traditional production mode, it is important to take into account short-termism in relation to the agency theory. This theory explores the various objectives of both agents and principals, which often results in an agency conflict between them (Gryglewicz *et al.*, 2020). According to agency theory (Jensen and Meckling, 1976), the conflict between principals and agents can be reduced through increased transparency of information (Cuijpers and Peek, 2010). Nowadays, the emergence of the digital economy is propelled by technological advancements. These technologies have had a profound impact on the mode of production (Chen *et al.*, 2022), enhancing firms' capabilities in processing information. The implementation of this measure has resulted in a significant enhancement of information transparency and corporate governance. The digital transformation of enterprises has experienced a consistent growth, as evidenced by the study conducted by Davis and DeWitt (2021). Given the substantial expansion of digital technologies, it is imperative to establish the second research inquiry: What impact will enterprises' digital transformation have on the correlation between managerial short-termism and green innovation?

Through the empirical tests, we investigate two specific inquiries. Based on the theoretical frameworks of temporal orientation and upper echelon theory, our empirical analysis demonstrates that the adoption of short-term managerial perspectives has a negative effect on the implementation of green innovations inside firms. Furthermore, upon closer examination of the notion of short-termism within the context of agency theory, it becomes apparent that digital transformation plays a substantial role in alleviating the adverse effects of managerial short-termism on green innovation. The moderating mechanism refers to the concept that the adoption of digital transformation brings about benefits in improving corporate governance, which in turn results in a rise in investments in green research and development (R&D). In addition, it is noteworthy that the examination of heterogeneity demonstrates that the statistically significant positive moderating effect of digital transformation is exclusively observed in companies that exhibit lower corporate governance, less analyst coverage and are non-state-owned enterprises (non-SOEs).

The possible contributions of this paper are summarized below. First, a substantial amount of scholarly study has been undertaken to investigate the effects of management short-termism on many dimensions of organizations' performance, encompassing overall innovation and firm value [Xu and Yang \(2023\)](#). Enterprise green innovation is a necessary and imperative decision to facilitate and advance green development. Currently, the world is confronted with a pressing issue of severe resource and environmental problems because of the frequent occurrence of environmental pollution cases and haze weather conditions. In the present context, it is imperative to examine the influence of managers' lack of foresight on the implementation of environmentally sustainable practices within corporations. Nevertheless, insufficient emphasis has been devoted to examining the effects of managerial short-termism on the progress of green innovation. By evaluating the effect of management short-termism on the decline of green innovation, our study adds to the body of previous studies. Second, this study aims to present supplementary empirical findings regarding the determinants of green innovation. Prior literature examines the factors influencing green innovation from two distinct perspectives. From an internal perspective, the green core competence, robot adoption and multi-nationality of a firm have been identified as factors that influence green innovation ([Tolliver et al., 2021](#)). Externally, the influence of government regulations and political connections is also significant ([Wang et al., 2022](#)). A novel approach to examining the factors influencing management characteristics is presented in our study, thereby contributing fresh perspectives to the existing theories on executives and broadening the scope and understanding of this field. Third, the process of digital transformation instigates alterations in both production and operational methodologies. The decision-making process of managerial strategies will also be impacted by digital transformation, as it enhances the transparency of information. In the Chinese context, a growing number of companies are recognizing the importance of digital transformation. The prevailing focus of existing studies generally is on the immediate consequences of digital transformation, with a limited body of literature exploring its moderating influence. Nevertheless, it is crucial to recognize that the ultimate accountability for decision-making lies with managers, rather than with robots. Hence, digital transformation also serves as a moderating factor. The main purpose of this study is to fill a space in current research by examining the impact of digital transformation on the relation between managerial short-termism and green innovation. Furthermore, the findings reported in this research provide a significant contribution by delivering useful insights and inspiration for emerging economies.

The next sections are structured as following. Section 2 presents a thorough literature analysis and describes the formulation of hypotheses. Section 3 displays a comprehensive

summary of the research design. Section 4 gives the outcomes of the baseline and robustness results. Section 5 presents a comprehensive outcomes of heterogeneity checks. Section 6 of the paper provides an in-depth examination of the moderating mechanism. Section 7 functions as the concluding section.

2. Literature review and hypotheses development

2.1 Literature review

The concept of green innovation refers to the deliberate efforts made to reduce or alleviate the adverse environmental impacts associated with the production or management of goods, with the ultimate goal of improving environmental management effectiveness (Chen *et al.*, 2006). In contrast to conventional innovation, green innovation encompasses a diverse range of economic, social and ecological advantages. According to Yu *et al.* (2021), this form of economic activity is characterized by significant expenses, heightened levels of uncertainty, delayed effects and beneficial external effects. Presently, a considerable proportion of academic discussions pertaining to green innovation mostly revolves around the analysis of internal issues within firms. Researchers argue that several external factors, such as the progress of digital inclusive finance (Guo *et al.*, 2022), environmental legislation and digitalization (Shin *et al.*, 2023), may influence the level of green innovation in businesses. Few scholars have examined determinants of green innovation in relation to the specific attributes of corporate managers. These individuals are proponents of the concept of hierarchical levels. They argue that the cognitive abilities and values demonstrated by enterprise managers, who are considered the primary decision-makers, have a significant impact on their perception of the business environment. Consequently, this perception influences their strategic decision-making (Hambrick and Mason, 1984). CEOs with an arrogant disposition tend to overestimate the likelihood of success in green innovation initiatives while simultaneously underestimating the potential for failure (Arenas *et al.*, 2018). As a result, these chief executive officers demonstrate a higher inclination to allocate resources toward initiatives focused on environmentally sustainable innovation. However, there is a scarcity of research that has been undertaken to examine the impact of management short-termism on green innovation.

2.2 Managerial short-termism and green innovation

In fact, the Theory of Principal and Agent, proposed by Jensen and Meckling (1976), has been a significant concern within the academic community, particularly in relation to management short-termism (Zhang and Wang, 2023). Lewin (1942) posits that individuals possess distinct time orientations. According to the upper echelons theory, the managers' short-term time orientation is likely to have an impact on their selection and pursuit of social goals, consequently influencing their behavioral motivations. The inclination of managers toward short-termism compels them to prioritize immediate and expedient gains in their corporate decision-making processes and, in some cases, exploit information asymmetry to mislead investors. Managers who prioritize short-term returns are less likely to engage in innovative activities that involve high costs, elevated risks (Brochet *et al.*, 2015). Managerial short-termism indicates a diminished tendency toward engaging in green innovation initiatives that create positive externalities. The existence of a myopic manager enhances the probability of an organization engaging in the concealment of substantial flaws. This may manifest through the use of earnings management strategies, including the reduction of controllable expenditures and the selective disclosure of financial information, all for personal benefit. Additionally, such a manager may disregard green innovation initiatives (Xu *et al.*, 2021). For instance, Arici and Uysal (2022) argue that the lengthy investment cycle, high risk of failure, limited comparability and unpredictable nature of green innovation make it challenging for shareholders to

effectively monitor companies' green innovation practices. Ultimately, this phenomenon results in elevated agency costs linked to corporate green innovation and exposes a lack of enthusiasm among managers to participate in green innovation. Hence, we put forward the initial hypothesis as follows:

H1. Managerial short-termism reduces green innovation.

2.2 The moderating role of digital transformation

[Jackson and Petraki \(2011\)](#) proposed that the phenomenon of managerial short-termism is not solely a result of the intricate interplay between various stakeholders' incentives and orientations but also encompasses a multitude of intricate interactions between managers and shareholders. Hence, it is imperative to analyze the notion of short-termism within the context of agency theory, which investigates the divergent goals of agents and principals, leading to a state of agency conflict. [Sappideen \(2011\)](#) provides support for this perspective and asserts that the prevalence of short-term thinking can be attributed to the structural changes resulting from managerial compensation based on agency theory.

According to agency theory, the conflict between principals and agents can be reduced through increased transparency of information ([Cuijpers and Peek, 2010](#)). [Butler et al. \(2007\)](#) have substantiated the notion that an increased frequency of disclosure could potentially enhance the information environment of a firm ([Glosten and Milgrom, 1985](#)), thereby facilitating more effective monitoring of managerial decisions by market participants ([Stulz, 2009](#)). Additionally, the study conducted by [McNichols and Manegold \(1983\)](#) found evidence to support the notion that increased information transparency has a substantial impact on actual investment choices ([Badertscher et al., 2013](#)).

On the other side, digital transformation primarily encompasses the use of digital technologies and the resulting digital resources within traditional enterprises. This includes the strategic application, production processes and management of digital technologies. The manifestation of the moderating effect of digital transformation on managerial short-termism and green innovation can be observed in two distinct aspects.

First, there is a contention that the adoption of digital transformation possesses the capability to augment internal control systems within corporate entities, thereby leading to improved corporate governance outcomes. An internal control system plays a crucial role within the accounting system ([Wang et al., 2018](#)). When a listed company's internal controls are determined to be deficient or insufficient, it often means that managers are abusing resources for their own benefit, which will result in a misrepresentation of financial resources ([Qi and Zhang, 2014](#)). The use of digital technologies has the potential to enhance financial control by means of a digital information sharing center, as well as enhance operative control. Intelligent technologies possess the capacity to augment the efficiency of corporate management across the entire spectrum of the producing process. Companies can use technologies, which include neural network analysis, to autonomously monitor and detect internal control deficiencies. Deep learning algorithms has the capacity to efficiently tackle complex challenges that present difficulties in quantification within the domain of internal control within enterprises ([Li et al., 2022](#)). Therefore, the implementation of digital transformation has the capacity to enhance internal corporate governance. Corporate governance effects compel managers to decrease their focus on short-term investments and compel them to engage in environmentally friendly R&D investments.

Second, the process of digital transformation has the potential to garner increased attention from analysts, thereby leading to the realization of corporate governance benefits. Analysts fulfill the crucial function of serving as information intermediaries between companies and external stakeholders. They engage in the analysis of reports, make

predictions about earnings, provide stock ratings and offer recommendations. This serves the purpose of mitigating information asymmetry, thereby minimizing agency conflicts. Previous studies have provided evidence that the supervision of analysts can be an effective measure in curbing opportunistic behavior by management, specifically in the context of earnings management. According to [Chen et al. \(2015\)](#), the impact of external corporate governance is significantly pronounced. For the notable significance of advancements in the digital economy, organizations that choose to integrate digital technology frequently garner heightened attention from analysts and emerge as the key focal points of their studies. The use of this approach is expected to yield substantial enhancements to the corporate governance function of analysts inside digital transformation organizations, hence leading to the optimization of investment decisions undertaken by management. Consequently, an elevated degree of external corporate governance assumes a supervisory function in motivating managers to reduce their emphasis on short-term investments.

Based on the effects of digital transformation on corporate governance, it can be observed that digital transformation leads to increased oversight of managers, resulting in a decline in short-term investments and a rise in investments in R&D. Therefore, we put forward the following hypothesis:

- H2.* Digital transformation reduces the adverse influence of managerial short-termism on green innovation.

3. Data, variables and methodology

3.1 Data

The databases used in this study were sourced from the China Stock Market Accounting Research database (CSMAR) and the Chinese Research Data Services Platform database. The source stated above provides extensive information regarding many attributes of firms, including ownership structure, geographical location and financial data. The latter provides insights into the concept of innovation. The primary focus of our analysis pertains to a sample consisting of Chinese A-shares listed companies spanning the time frame from 2001 to 2021. Annual financial reports for listed companies can be accessed on [cninfo.com](#) [1]. By using a stock code, the integration of the two databases is facilitated. Next, we will exclude observations that meet any of the following criteria:

- companies listed in the financial and insurance sectors;
- companies listed as ST, ST* and PT; and
- observations with missing or abnormal values for the main variables.

Total continuous variables undergo winsorization at the 1% and 99% levels. Finally, 35,635 firm-year observations were obtained.

3.2 Variables

3.2.1 Managerial short-termism. To evaluate the degree of managerial short-termism, we use the managerial short-termism index at the firm level, as devised by [Xu and Yang \(2023\)](#). The formulation of this index encompassed a three-step procedure. At the outset, a collection of terms associated with the concept of short-termism was identified. Furthermore, the researchers used Word2vec machine learning methodologies to enhance the initial collection of seed words. Finally, the researchers used the dictionary approach to calculate the proportion of words in the Management Discussion and Analysis section that are associated with short-termism, relative to the total number of words. [Figure 1](#) illustrates that Chinese

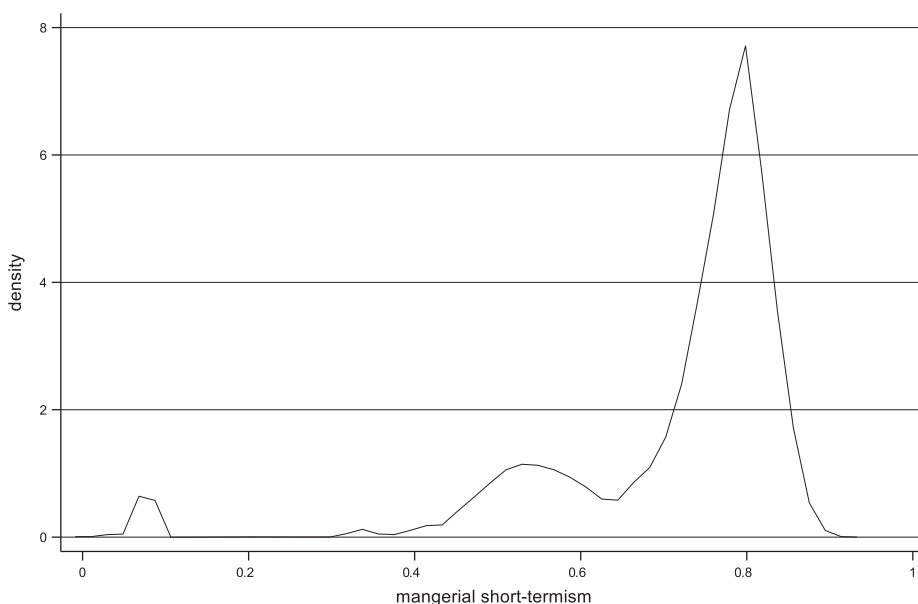


Figure 1.
The distribution of
managerial short-
termism index

Source: Figure 1 by authors

A-share listed firms exhibit a significant degree of managerial short-termism, as evidenced by their high average level.

3.2.2 Green innovation. Based on extensive research, green patent applications serve as a measure for evaluating the magnitude of green innovation. In light of the absence of any green patent applications, it becomes imperative to use the logarithm of the count of green patent applications plus one, as a means to tackle the problem of right-skewed distributions observed in patent applications.

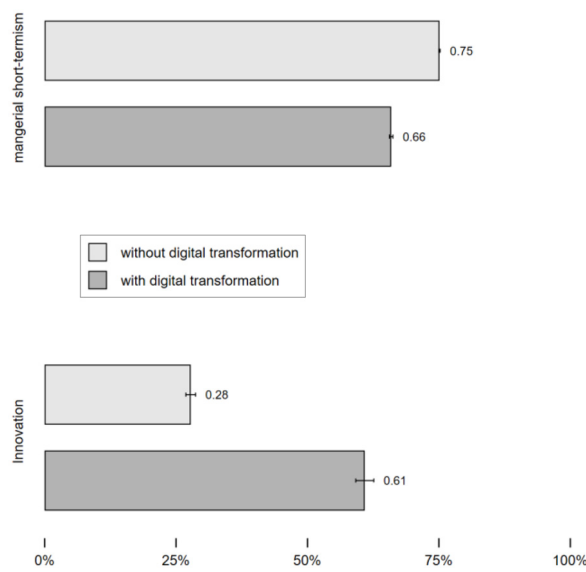
3.2.3 Digital transformation. The data pertaining to firms' digital transformation level is sourced from the CSMAR data set. The data set uses textual analysis techniques to quantify the extent of digital transformation. The higher numerical value signifies a greater level of digital transformation. In this paper, we use the logarithm of the relevant value in the CSMAR data set, incremented by one, as a measure of digital transformation.

Figure 2 illustrates that companies lacking digital transformation exhibit elevated levels of managerial short-termism, while simultaneously displaying diminished levels of green innovation.

3.2.4 Other variables. Based on previous research, we additionally control a set of variables as follows:

First, it has been observed that large-scale enterprises often enjoy economic scale advantages and possess greater financial resources to facilitate innovation activities. However, the implementation of large-scale operations may give rise to various challenges, including suboptimal use of internal resources, intricate organizational structures and a tendency toward conformity, all of which can hinder innovation. We quantify the scale of a firm by taking the logarithm of total assets.

Figure 2.
Comparison of
managerial short-
termism and
innovation between
firms



Source: Figure 2 by authors

According to [Shao and Wang \(2023\)](#), firms with a longer duration exhibit a stronger innovation consciousness and a more developed innovation ability. We used the natural logarithm of the duration of listing as a metric to assess the age of the firm.

Third, the profitability of a firm plays a crucial role in generating consistent cash flow for innovation. To measure the firm’s profitability, the ratio of net profit to total assets is commonly used.

Another source of heterogeneity lies in the higher management efficiency, which enhances monitor effectiveness and incentivizes managers to engage in green innovation. We use the index developed by [Demerjian *et al.* \(2012\)](#) to assess the efficiency of management.

Fifthly, increased competition in the product market assumes an external governance function in shaping the behaviors of firms. Green innovation is a noteworthy source of competitive advantage, leading firms to intensify their endeavors in green innovation in face of escalating competitiveness inside the product market. The evaluation of competition in the product market is carried out by using the Herfindahl-Hirschman Index.

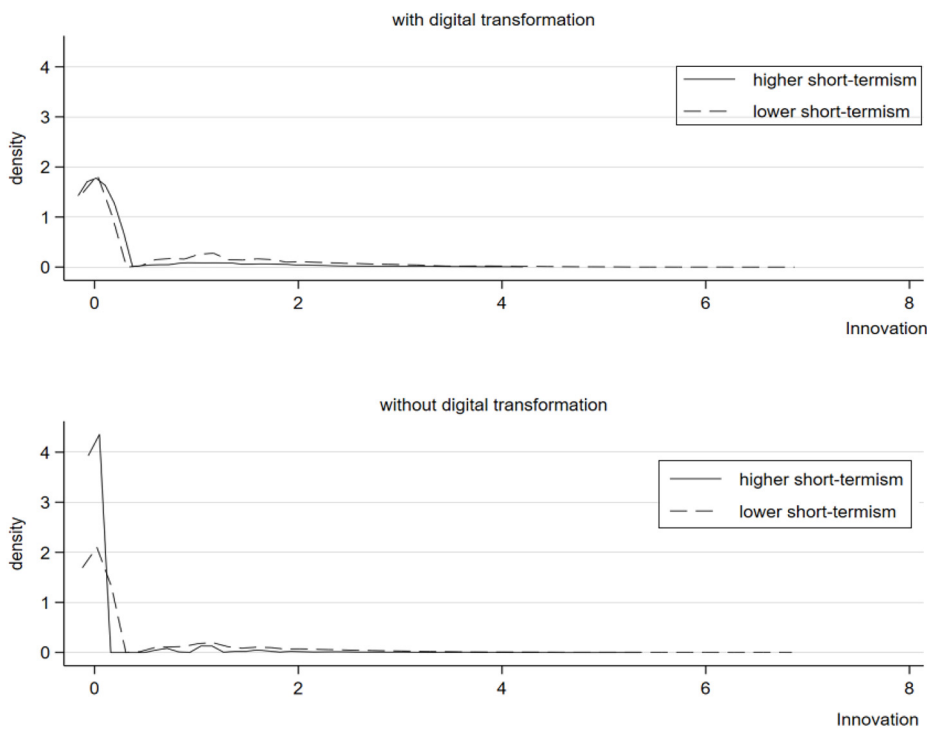
Sixthly, the allocation of government subsidies has the potential to successfully alleviate financial limitations and act as a catalyst for enterprises to actively participate in green innovation. Government subsidies is determined by taking the natural logarithm of the amount of government subsidies and adding one.

3.2.5 Descriptive analysis. [Table 1](#) presents the average and standard deviation of green innovation are 0.3991 and 0.8479, respectively. This suggests a significant disparity among firms in terms of their level of green innovation. For additional variables, it is also possible to suggest that there may be variations among firms in terms of managerial short-termism, firm size, productivity and other factors to some degree.

[Figure 3](#) illustrates that firms lacking digital transformation exhibit a greater number of firms with zero innovation when compared to firms characterized by lower levels of managerial short-termism. For companies undergoing digital transformation,

Table 1.
Summary statistics

Var	Mean	SD
<i>Innovation</i>	0.3991	0.8479
<i>digital</i>	0.6875	1.1064
<i>short</i>	0.7175	0.1471
<i>TFP</i>	8.2236	1.0876
<i>ROA</i>	0.0331	0.0962
<i>Age</i>	2.7073	0.4257
<i>HHI</i>	0.1236	0.1331
<i>MF</i>	−0.0646	0.9729
<i>Subsidy</i>	15.9618	1.9939

Source: Table 1 by authors**Figure 3.**
Managerial short-termism, digital transformation and innovation**Source:** Figure 3 by authors

the dissemination of innovation appears to be comparable between with varying degrees of managerial short-termism. In addition, when comparing firms that have undergone digital transformation and those that have not, it is evident that the average number of firms with zero innovation is lower among those that have undergone digital transformation.

3.3 Methodology

In this paper, equation (1) is used to examine *H1*:

$$Inno_{it} = \alpha_0 + \beta_1 short_{it} + \beta_2 Control_{it} + \delta_t + \lambda_i + \varepsilon_{it} \quad (1)$$

where $Inno_{it}$ represents company i 's green innovation performance in year t ; $digital_{it}$ indicates company i 's digital transformation degree in year t ; and $Control_{it}$ includes a series of control variables. δ_t and λ_i represent year fixed effect and firm fixed effect, respectively [2]. ε_{it} is the error term.

Next, we develop equation (2) to test *H2*:

$$Inno_{it} = \beta_0 + \beta_1 short_{it} + \beta_2 short_{it} \times digital_{it} + \beta_3 digital_{it} + \Gamma X_{it} + \lambda_i + \delta_t + \varepsilon_{it} \quad (2)$$

where $digital_{it}$ indicates company i 's digital transformation degree in year t .

Further, based on Xavier (2011), we develop equation (3) to test the heterogeneous moderating effects of digital transformation:

$$Inno_{it} = \alpha_0 + \beta_1 (short_{it} \times digital_{it} \times I_{it}) + \gamma' X_{it} + \delta_t + \lambda_i + \varepsilon_{it}, \quad (3)$$

where I_{it} denotes the position of firm i in year t within the fractile distribution of internal corporate governance level (CGI) and analyst coverage level, indicating whether it falls into the lowest, medium or highest category. Furthermore, ownership can be classified into SOEs and non-SOEs. The standard errors presented in all models are derived from the consideration of heteroscedasticity and sample clustering at the firm level.

4. Empirical results

4.1 Baseline results

The baseline findings are presented in Panel A of Table 2. The results of the study demonstrate that the coefficients representing managerial short-termism are negatively associated with green innovation, which is statistically significant at a 1% level of significance. This implies that the tendency toward short-term thinking among managers acts as a barrier to the advancement of environmentally friendly innovation. The coefficient of the variable "short" demonstrates a statistically significant negative impact at a 1% level of significance, but only when taking into account firm fixed terms and year fixed terms. The use of various control variables does not significantly affect the consistency of the results obtained from M2 to M4. The model M5 includes control variables, company fixed effects and year fixed effects. The obtained coefficient value of -0.3518 indicates that an increase of one standard deviation in managerial short-termism is associated with a drop of 9.75% ($= (0.3518 \times 1.1064) / 0.3991$) in allowed green innovation, as compared to the sample mean. Alternatively, this decrease corresponds to a reduction of 4.59% ($= (0.3518 \times 1.1064) / 0.8479$) relative to the standard deviation. Furthermore, these data offer further evidence to substantiate that management short-termism has a propensity to reduce the extent of green innovation.

Following this, equation (2) is used to test the moderating impact of digital transformation. The findings are displayed in Panel B of Table 2. The coefficients related to managerial short-termism demonstrate a statistically significant negative correlation. In contrast, the coefficient of the interaction term is statistically significant positive. This implies that digital transformation has a mitigating moderating role.

	M1	M2	M3	M4	M5
<i>Panel A</i>					
<i>short</i>					
<i>Cons</i>	–0.3189*** (0.0523) 0.6315*** (0.0134)	–0.3143*** (0.0511) 0.83392*** (0.0170)	–0.3364*** (0.0419) 0.2702 *** (0.0145)	–0.3456*** (0.0365) 0.8367*** (0.0326)	–0.3518*** (0.0302) 0.2879*** (0.0018)
<i>Control variables</i>	No	No	Yes	Yes	Yes
<i>Year-FE</i>	Yes	No	No	Yes	Yes
<i>Company-FE</i>	Yes	Yes	No	No	Yes
<i>Observations</i>	35,635	35,635	35,635	35,635	35,635
<i>Within R²</i>	0.0008	0.0506	0.0572	0.0591	0.0494
<i>Panel B</i>					
<i>short</i>					
<i>digital</i>					
<i>short × digital</i>					
<i>Cons</i>	–0.3312*** (0.0523) 0.0034*** (0.0009) 0.0196*** (0.0056) –3.9327 *** (0.1699)	–0.2587*** (0.0561) 0.0023** (0.0009) 0.0227*** (0.0058) 0.5822*** (0.0142)	–0.2773*** (0.0408) 0.0015* (0.0008) 0.0184*** (0.0047) 0.4334 *** (0.0116)	–0.2242*** (0.00398) 0.0024*** 0.0008 0.0157*** (0.0098) 0.2813*** (0.0098)	–0.2794*** (0.0335) 0.0018*** (0.0004) 0.2747*** (0.0085) 0.2747*** (0.0085)
<i>Control variables</i>	No	No	Yes	Yes	Yes
<i>Year-FE</i>	Yes	No	No	Yes	Yes
<i>Company-FE</i>	Yes	Yes	No	No	Yes
<i>Observations</i>	35,635	35,635	35,635	35,635	35,635
<i>Within R²</i>	0.0594	0.0478	0.0571	0.0619	0.0494

Notes: *, ** and *** indicate statistical significance at the 10, 5 and 1% levels, respectively. The standard errors are corrected for clustering at the firm level
Source: This table is offered by authors

Table 2.
Baseline results

4.2 Endogeneity issues

In accordance with the methodology proposed by Xu and Yang (2023), we use the two-stage residual inclusion approach to address endogeneity concerns. First, equation (4) is used to derive the instrumental variable (IV) for managerial short-termism (IV).

$$short_{it} = \alpha_o + \alpha_1 Short_invest_{it} + \alpha_2 Turnover_{it} + \alpha_3 MF_{it} + \Gamma X_{it} + \sum Year + \sum Industry + \varepsilon_{it} \tag{4}$$

where *Short_invest* denotes the proportion of short investments, *Turnover* signifies the rates of shareholder turnover and *MF* represents the count of earnings announcements made by management.

The findings obtained using two-stage residual inclusion estimate method are presented in Table 3. The outcomes of the first phase are displayed in M1 and M3, while the results of the subsequent phase are depicted in M2 and M4. We observe that the coefficients of the independent variable (IV) exhibit a statistically significant positive correlation at the 1% level of significance. The statement suggests a positive correlation between independent variables (IV) and managerial short-termism. The statistical data obtained from the Cragg-Donald Wald F statistic and Kleibergen-Paap rk LM (*p*-value) tests provide evidence on the efficacy of the instrument variable (IV). The results obtained from the subsequent phase of analysis provide additional support for the concept that short-term thinking has a negative effect on the performance of corporate social responsibility. Hence, the results obtained from our research exhibit a considerable degree of resilience.

4.3 Robustness checks

4.3.1 New measures. The selection of the method used to assess variables significantly impacts the results obtained from regression analysis. The determination of managerial short-termism levels involves calculating the ratio between the average duration of investors' stock holdings and the average number of trading days in a particular year. The findings reported in M1 of Table 4 are consistent with the earlier results. The empirical data given in Module 2 of Table 4 align with the baseline results where the level of digital

Variables	M1	M2	M3	M4
IV	0.4510*** (0.0439)		0.4137*** (0.0318)	
short		−0.4587*** (0.0561)		−0.4379** (0.0365)
Digital	0.0207** (0.0099)	0.0621*** (0.0147)	0.0793*** 0.01806	0.0796*** (0.01806)
short × digital	0.0873*** (0.0209)	0.0873*** (0.0209)	0.0190* (0.0099)	0.0189*** (0.0096)
Control variables	No	No	Yes	Yes
Year	Yes	No	No	Yes
Company	Yes	Yes	No	No
Observations	35,635	35,635	35,635	35,635
Within R ²	0.2258	0.1486	0.2356	0.2357
Cragg-Donald Wald F statistic	28,173.58	2,680.277	2,678.750	2,680.845
Kleibergen-Paap rk LM (<i>p</i> -value)	0.0000	0.0000	0.0000	0.0000

Table 3.
Endogeneity issues

Notes: Control variables are in Table 1. *, ** and *** indicate statistical significance at the 10, 5 and 1% levels, respectively. The standard errors are corrected for clustering at the firm level
Source: This table is offered by authors

Variables	M1	M2	M3	M4	M5	M6
<i>Short digital</i>	−0.4718*** (0.0000)	−0.4718*** (0.0000)	−0.3327*** (0.0113)	−0.3302*** (0.0090)	−0.3083*** (0.0030)	−0.3014*** (0.0074)
<i>Short × digital</i>	0.0627*** (0.0169)	0.0627*** (0.0169)	0.0294*** (0.0022)	0.0822*** (0.0151)	0.0471*** (0.0032)	0.0158*** (0.0012)
<i>Cons</i>	0.0792*** (0.0070)	0.0792*** (0.0070)	0.0952*** (0.0243)	0.0758*** (0.0063)	0.0674*** (0.0047)	0.0501*** (0.0055)
<i>Control variables</i>	0.3876*** (0.0169)	0.3876*** (0.0169)	0.0244*** (0.1700)	0.4849 *** (0.0192)	0.3628 *** (0.0059)	0.4178*** (0.0783)
<i>Year</i>	Yes	Yes	Yes	Yes	Yes	Yes
<i>Company</i>	Yes	Yes	Yes	Yes	No	Yes
<i>Industry-year</i>	No	No	No	No	No	No
<i>Observations</i>	35,635	35,635	26,367	8,777	35,635	35,635
<i>Within R²</i>	0.0029	0.0029	0.0033	0.0043	0.0051	
<i>Pseudo R²</i>						0.0640

Notes: Control variables are in Table 1. *, **, and *** indicate statistical significance at the 10, 5 and 1 % levels, respectively. The standard errors are corrected for clustering at the firm level

Source: This table is offered by authors

Table 4.
Robustness checks

transformation is estimated by using the ratio of digital-connected intangible assets to total intangible assets.

4.3.2 New sample. Taking into account the impact of the 2008 worldwide financial crisis, the sample for this study was selected from the years 2010 to 2021. M3 of Table 4 presents robust benchmark results.

We conducted a regression analysis using propensity score-matched samples to mitigate potential sample selectivity bias. Firms categorized within the top 1/3 of their respective industries in terms of digitization levels are assigned to the treatment group, while all other firms are assigned to the control group (Jiang *et al.*, 2022). Each firm in the experimental group is paired in a 1:1 ratio with the nearest firm in the control group and only the sample which fulfills the common support hypothesis is retained. In M4 of Table 4, the results indicate the robustness of our findings.

4.3.3 New model setting. We use an interactive fixed-term approach, spanning across industry-years, to reassess the baseline findings. Controlling for firm fixed effects or year fixed effects only takes into account the uniform shocks in the firm dimension or time dimension, respectively. However, these shocks may have varying effects on different types of enterprises. To effectively account for the influence of unobservable heterogeneous shock factors, it is necessary to incorporate interactive fixed effects into the regression equation. The obtained results exhibit a high level of robustness (Table 4, M5).

Next, we transition to using a Tobit model. The findings in M6 continue to support our baseline results, as indicated in Table 4, M6.

5. Heterogeneity checks

5.1 Internal corporate governance

First, we examine the diversity within internal corporate governance. The implementation of robust internal corporate governance mechanisms has the promise of bolstering the efficacy of monitoring activities and fostering managerial engagement in R&D investment initiatives. Therefore, the implementation and enforcement of effective corporate governance measures possess the capacity to mitigate the adverse effects of short-term management practices on green innovation. The effectiveness of digital transformation in addressing the negative consequences of managerial short-termism on environmentally friendly innovation may be limited in businesses that possess strong internal corporate governance mechanisms.

The CGI developed by Yu *et al.* (2017) is used as a quantitative measure to evaluate the effectiveness of internal company governance. The index offers a detailed depiction of the internal governance frameworks of all Chinese companies that are publicly listed on the stock market. M1 of Table 5 shows that the positive moderating effects of digital transformation are only relevant to businesses that exhibit insufficient internal corporate governance.

5.2 Analyst coverage

Furthermore, the inclusion of analyst coverage heterogeneity is given due consideration. Empirical research has provided evidence to support that there is a positive correlation between the extent of analyst coverage and media coverage. This association results in heightened levels of information transparency and increased efficacy of internal monitoring. Hence, a higher degree of analyst coverage functions to alleviate managers' propensity for short-term orientation, thereby fostering their involvement in innovative endeavors. The potential influence of digital transformation in mitigating the negative consequences of management short-termism on green innovation may be diminished by the existence of analyst coverage, particularly in the case of companies that receive extensive attention from

Variables	M1	M2	M3
$Short \times digital \times SOE$			-0.2212 (0.2428)
$Short \times digital \times non - SOE$			0.3012*** (0.0012)
$Short \times digital \times LOWTER_{analyst}$		0.3376*** (0.0025)	
$Short \times digital \times MEDTER_{analyst}$		0.0336 (0.0310)	
$Short \times digital \times HIGHTER_{analyst}$		0.0382 (0.0311)	
$Short \times digital \times LOWTER_{CGI}$	0.0312*** (0.0012)		
$Short \times digital \times MEDTER_{CGI}$	-0.0428 (0.1237)		
$Short \times digital \times HIGHTER_{CGI}$	-0.0339 (0.1362)		
Control variables	Yes	Yes	Yes
Company Fixed	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes
_Cons	0.3421*** (0.0000)	0.3382*** (0.0000)	0.3454*** (0.0000)
N	35,635	35,635	35,635
Adjust R ²	0.0636	0.7144	0.08421

Notes: Control variables are in Table 1. *, ** and *** indicate statistical significance at the 10, 5 and 1 % levels, respectively. The standard errors are corrected for clustering at the firm level. The dependent in M1, M2 and M3 is CGI, analyst coverage and ownership, respectively

Source: This table is offered by authors

Table 5.
Heterogeneity checks

analysts. The information regarding a company's analyst coverage is from the CSMAR database. Model 2 of [Table 5](#) suggests that the positive moderating impact of digital transformation is noteworthy exclusively for firms lacking analyst coverage.

5.3 Ownership

The analysis of corporate status and the differentiation between SOEs and non-SOEs holds significant significance in academic discourse. It has been argued by [Liu and Zhang \(2017\)](#) that SOEs will inevitably assume a greater level of social responsibility. However, it appears that managers of SOEs do not prioritize corporate performance. Non-SOE managers, on the other hand, encounter heightened market pressures, leading to increased concerns regarding their professional trajectories. Hence, managers of SOEs are inclined toward participating in green innovation. Consequently, digital transformation could potentially facilitate green innovation more efficiently in non-SOEs.

Firms' ownership data is obtained from the CSMAR data set. The classification of a company as a SOE is determined based on its indication in the CSMAR data basement. If the company is identified as an SOE in the CSMAR data basement, then it is considered a SOE; otherwise, it is not classified as an SOE. The findings in M3 of [Table 5](#) support that for non-SOES, the moderating role of digital transformation is statistically significant.

6. Moderating mechanism

The primary variable under consideration is the dependent variable, specifically the investment in green research and development as indicated in Column 1 of [Table 6](#). This variable is estimated by using green R&D expenses divided by the total operating revenues. The results suggest that the allocation of resources toward green R&D activities by enterprises is negatively impacted by the tendency of managers to prioritize short-term goals and outcomes.

Furthermore, the evaluation of information processing capability is accomplished through the use of information technology capital ([Li et al., 2021](#)). The findings shown in the second column [Table 6](#) illustrate the evident capacity of digital transformation to enhance the information processing skills of companies. The findings derived from Columns 3 and 4 [Table 6](#) demonstrate that the digital transformation process significantly enhances the internal corporate governance level and analyst coverage of firms.

Furthermore, the results reported in Column 6 of [Table 6](#) offer empirical support for the notion that digital transformation acts as a constructive moderating influence in alleviating the adverse consequences of management short-termism on green R&D expenditure.

Based on the aforementioned facts, one could submit a hypothesis that the practice of management short-termism has a detrimental impact on green innovation because of its tendency to decrease investments in green R&D. Furthermore, the digital transformation process aims to alleviate the negative impacts of managerial short-term thinking on environmentally friendly innovation by improving corporate governance and so promoting greater investments in green research and development.

7. Conclusion

This study is to empirically examine the influence of management short-termism on green innovation within the context of Chinese A-share listed firms. Additionally, this paper investigates the moderating influence of digital transformation. The main results indicate that the presence of management short-termism mitigates green innovation of firms. Furthermore, digital transformation has a positive impact on addressing the negative consequences of managerial short-term thinking on environmentally friendly innovation.

Variables	Green R&D	Information processing ability	Corporate governance	Analyst coverage	Green R&D
<i>Short digital</i>	-0.3312*** (0.0523)				-0.2794** (0.0335)
<i>Short × digital</i>		0.2587*** (0.0561)	0.1527*** (0.0058)	0.2157*** (0.0098)	0.0118*** (0.0004)
<i>Cons</i>	0.9327 *** (0.1699)	0.5822*** (0.0142)	0.3162*** (0.0076)	0.2813*** (0.0098)	0.2747*** (0.0085)
<i>Control variables</i>	No	Yes	Yes	No	Yes
<i>Year</i>	Yes	Yes	Yes	Yes	Yes
<i>Company</i>	Yes	Yes	Yes	Yes	Yes
<i>Observations</i>	35,635	35,635	35,635	35,635	35,635
<i>Within R²</i>	0.0594	0.0578	0.0473	0.0319	0.0494

Notes: *, ** and *** are used to denote statistical significance at the 10, 5 and 1% levels, respectively. The standard errors have been adjusted to account for clustering at the level of the firm

Source: This table is offered by authors

Table 6.
Moderating
mechanism

The advantageous moderating impact of digital transformation is notably observable in organizations distinguished by diminished levels of internal corporate control, little analyst coverage and non-SOEs.

The key findings of this study possess noteworthy policy inspirations. First, the primary finding demonstrates that managerial short-termism leads to decrease of green innovation. Following the upper echelons theory, the decision-making process of managers is influenced by managerial short-termism, which in turn affects their strategic choices. Therefore, when firms are selecting and training senior managers, it is crucial for enterprises to consider the time orientation characteristics of these managers. Second, our findings indicate that the enhanced information processing capability resulting from digital transformation plays a significant role in enhancing corporate governance outcomes. Therefore, it is imperative for organizations to actively promote the process of digital transformation, while governments should play a crucial role in providing support to these firms to enable them to fully leverage the benefits of digital technologies. Furthermore, for SOEs or companies that receive limited analyst coverage, it is imperative for them to enhance their internal corporate governance practices or embark on digital transformation initiatives. From a policy perspective, it is imperative for local governments to prioritize the expansion of digital infrastructure construction and offer comprehensive support to businesses to facilitate their digital transformation.

In the context of our inquiry, it is imperative to recognize the presence of limitations. The precise assessment of the magnitude of digital change within enterprises remains a prominent area of inquiry. Moreover, it is crucial to improve the measurement of indicators related to digital transformation. Moreover, the findings of our research are derived from a representative sample of Chinese A-share listed companies. The relation between managerial short-term orientation and environmentally sustainable innovation in alternative markets can be influenced by divergent regulatory regimes. Therefore, undertaking a thorough examination of regional disparities would be both intellectually stimulating and of great importance.

Note

1. www.cninfo.com.cn/new/index.

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