



Can enterprise green transformation inhibit accrual earnings management? Evidence from China

Yufei Lei ^a, Yucong Yan ^{a,*}, Chen Chen ^b, Tianyao Luo ^c, Yingdong Wang ^a, Hao Wu ^d

^a School of Finance, Zhongnan University of Economics and Law, Wuhan 430073, China

^b School of Management, Guangdong University of Technology, Guangzhou, 510520, China

^c School of Business, Xinjiang University, Urumqi 830046, China

^d School of Statistics and Mathematics, Zhongnan University of Economics and Law, Wuhan 430073, China

ARTICLE INFO

Keywords:

Green transformation
Earnings management
Analyst tracking
Financing constraints

ABSTRACT

This study theoretically and empirically analyzes the impact and mechanism of corporate green transformation on accrual earnings management using a sample of China's A-share listed companies from 2015 to 2021. The results indicate that the green transformation of enterprises helps restrain accrual-based earnings management, especially accrual-based earnings management, which increases profits, and that the inhibition effect of enterprise green transformation on earnings management is more significant in high-tech and growth-stage enterprises. The mechanism test shows that corporate green transformation can inhibit accrual-based earnings management by increasing analyst follow-up and easing financing constraints. Using China's environmental tax law, promulgated in 2018, as an exogenous shock to construct the PSM-DID, the conclusion still holds after alleviating endogeneity. Further research has found that green transformations can also help inhibit real earnings management. This study provides new empirical evidence for a comprehensive understanding and evaluation of the governance role of corporate green transformation and provides a reference value for further comprehensively promoting the green transformation of Chinese enterprises and improving the quality of accounting information.

1. Introduction

With the continuous adoption of an extensive economic growth model in recent years, China has become the second largest economy in the world. However, this extensive economic growth has seriously damaged China's environmental resources, making China's total greenhouse gas emissions the highest in the world [1]. The green economy has always been an important tool for

* Corresponding author.

E-mail address: yanyucong1996@163.com (Y. Yan).

developing countries to achieve sustainable development [2]. Therefore, to avoid environmental degradation caused by greenhouse gas emissions and political pressure affecting sustainable economic development, the Chinese government has proposed a series of economic development strategies based on environmental protection.¹ The Chinese government's green development method of "promoting the construction of a resource-saving and environmentally friendly society" reflects the determination and attitude of the government in formulating and implementing new development policies during the transformation period of national economic development [3]. China's listed companies have long been the main source of carbon emissions.² Today, with increasingly serious environmental problems, the traditional "high carbon emission" development model of listed companies is unsustainable, and companies must choose a development path that takes into account both economic and environmental benefits [4], and green transformation can just become an important driving force for the sustainable development of the corporate economy [5]. Therefore, given the Chinese government's vigorous promotion of the sustainable development of the green economy based on the "dual carbon" goal, the green transformation of listed companies has become a hot topic of concern in all walks of life.

Earnings management refers to the behavior in which the enterprise management authority controls or adjusts the accounting income information reported by the enterprise based on accounting standards to maximize the interests of its own subjects. Academic circles generally divide earnings management into two categories: accrual-based and real earnings management. Accrual earnings management involves selecting and applying accounting policies to change the accounting period to which earnings belong, whereas real earnings management indirectly affects the cash flow of business operations, future business results, and economic interests of the company by manipulating transactions. Earnings management is a constant focus of corporate governance research [6]. Jensen and Meckling [7] believe that the separation of ownership and management rights in modern enterprises has led to information asymmetry, and managers may artificially interfere with the process of earnings reporting through accounting policy selection, accounting estimate changes, and so on, out of motivation to maximize their own interests [8]. This type of behavior has seriously affected the quality of corporate accounting information, rendering investors and creditors unable to make informed and reasonable decisions based on corporate accounting information, disrupting the country's economic order, reducing the efficiency of resource allocation in the capital market, and hindering the development of the country's economy.

In existing theory, the relationship between corporate green transformation and accrual-based earnings management is not clear. On the one hand, the improvement of corporate environmental information disclosure can attract more analysts to follow, and analysts can reduce accrual earnings management through supervision [9,10]. In addition, the green transformation of enterprises concentrates on profit growth while taking into account environmental protection [11]. The positive externalities brought about by environmental protection often make it more recognized by the public and the government, thus attracting more high-quality resources and business cooperation, where analyst tracking is an additional factor. Finally, the green transformation of enterprises can transmit "green signals" to financial institutions through environmental information disclosure [12], thereby gaining credit advantages, alleviating the financing constraints of enterprises, and reducing the motivation for earnings management. On the other hand, green transformation may increase a company's selling, general, and administrative expenses (SG&A), indirectly reducing stock returns [13], and thus increasing management's motivation for earnings management. Therefore, in the context of the sustainable development of China's green economy, strengthening research on the relationship between corporate green transformation and earnings management has important theoretical value and practical significance.

The research conducted in this study has the following three goals: first, to study the importance of corporate green transformation and its impact on accrual earnings management; and second, to explore the impact of green transformation on enterprises with different technological innovation capabilities and life cycles. The specific impact of enterprises on accrual earnings management and, third, an in-depth discussion of the impact channels of corporate green transformation on accrual earnings management. According to previous studies, there is no in-depth account of the impact of green corporate transformation on accrual-based earnings management. Therefore, the overall goal of this study includes theoretical demonstration, empirical testing, and enlightenment for future researchers in related fields, while also providing investors with a new way to analyze the quality of corporate accounting information.

This study selects China's A-share non-financial listed companies from 2015 to 2021 as the research object and empirically tests the relationship between corporate green transformation and accrual earnings management. The main research questions were as follows.

- (1) Can corporate green transformation effectively restrain accrual earnings management?
- (2) Is the impact of corporate green transformation on accrual earnings management heterogeneous due to differences in corporate technological innovation capabilities or corporate life cycles?
- (3) What is the impact channel of corporate green transformation on accrual earnings management?

¹ In September 2016, the Chinese government clarified the relationship between green and sustainable economic development at the G20 Summit in Hangzhou, emphasizing for the first time the importance of green economy to global economic development; in September 2020, at the 75th United Nations General Assembly, Chinese President Xi Jinping officially proposed the goal of achieving "carbon peak" in 2030 and "carbon neutrality" in 2060; in March 2021, the National People's Congress pointed out in the "14th Five-Year Plan" that "Clear waters and green mountains are as valuable as mountains of gold and silver", and emphasized the further promotion of green financial development and support for green technology innovation; in January 2023, China's State Council Information Office released "China's Green Development in the New Era", indicating that green industry has become a new driving force for economic growth.

² In 2021, the "China Listed Companies Carbon Emission Ranking (2021)" released by China's "Carbon Neutral Summit Forum" shows that the total carbon dioxide emissions of the 100 largest listed companies are 4.424 billion tons, exceeding 40 % of China's overall carbon emissions in that year.

The results show that green transformation can effectively restrain accrual-based earnings management. The inhibitory effect of corporate green transformation is more significant for positive earnings management. The heterogeneity analysis shows that the green transformation of enterprises can more effectively restrain accrual-based earnings management in high-tech and growth-stage enterprises. In addition, enterprises' green transformation can restrain accrual earnings management through channels such as increasing analyst tracking and easing financing constraints. We derived an adapted conceptual framework for this study (Fig. 1).

This study makes significant contributions to both theory and practice. In terms of theory, this study enriches empirical research on the economic consequences of corporate green transformation. Previous research on the microeconomic consequences of corporate green transformation has often focused on the increased financing and external attention brought about by environmental improvements and environmental performance improvements, but has not focused on the impact of corporate green transformation on corporate governance. Therefore, this study goes further on the previous basis and explores in depth whether the increase in financing and external attention brought about by the green transformation of enterprises can bring governance effects to enterprises and further improve their accounting information quality. This provides a reference for promoting the green transformation of enterprises and the sustainable development of China's green economy. It also provides new ideas for modern corporate governance theory and empirical evidence for the application of green transformation to corporate governance issues. Second, this study enriches and expands of the research on the factors affecting earnings management. Research on the factors affecting earnings management has mostly been conducted from the perspectives of the external market environment, corporate financing, and governance mechanisms. Few scholars have analyzed the "spillover" governance effects that green transformation brings to enterprises. Green transformation, one of the most important sustainable development strategies for enterprises, significantly impacts corporate governance. Therefore, this study is based on micro-level research on corporate financing and governance mechanisms and, from the perspective of corporate green transformation, a long-term development strategy, to further explore the factors influencing accrual-based earnings management. This provides a reference for enterprises to improve the quality of accounting information disclosure. Third, the results empirically demonstrate the internal mechanism of the impact of corporate green transformation on accrual earnings management from multiple perspectives. This study analyzes the impact mechanism of green transformation on accrual earnings management in detail from two perspectives: limiting the implementation space of accrual earnings management and eliminating the implementation motivation of earnings management. First, analyst tracking is selected to explore whether green transformation can restrain the implementation space of accrual earnings management through external corporate governance mechanisms. Second, financing constraints are selected to explore whether green transformation can eliminate the motivation of earnings management, which provides a more comprehensive reference for the mechanism analysis of related research. Fourth, this research addresses the deficiencies in dealing with endogeneity that previous studies have overlooked. Previous studies of green transformation omitted this area, which may have led to biased estimation results. This study takes the environmental protection "fee to tax" policy reform introduced by the Chinese government in 2018 as an exogenous impact, and uses PSM-DID to alleviate possible endogenous problems between corporate green transformation and accrual earnings management. This method of alleviating possible endogeneity problems from the perspective of exogenous policy shocks provides useful insights for subsequent related research on endogenous processing.

This study also offers practical implications. First, this research provides investors with a clearer and more reliable way to identify the quality of corporate accounting information. Investors can identify the quality of a company's accounting information through the number of green transformation words in the annual report disclosed by the listed company, thereby making more rational investment decisions. Second, the results have important practical significance for encouraging enterprises to actively carry out green transformation. Previous studies on the economic consequences of corporate green transformation have mainly focused on the environmental performance obtained from the level of environmental protection. Environmental protection has strong positive externalities. Enterprises are generally unwilling to sacrifice their own interests for environmental protection based on the principle of maximizing their own interests. Therefore, corporate green transformation often previously required strong government environmental policies such as green credit and the collection of environmental taxes. However, this study verified through empirical evidence that the green transformation of enterprises can help improve the quality of accounting information and enable them to develop better. This helps enterprises to correctly understand the advantages of green transformation to a certain extent and guide enterprises to actively carry out green transformation.

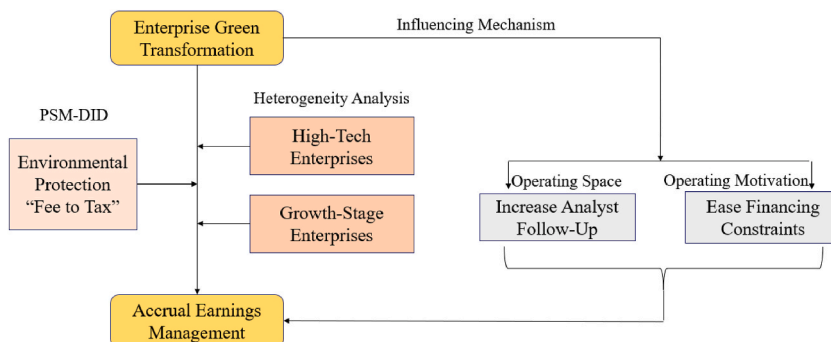


Fig. 1. Conceptual framework of the study.

The rest of this paper is organized as follows. Section 2 provides the literature review. Section 3 develops the theoretical framework and research hypotheses. Section 4 describes the research design. Sections 5 and 6 present and discuss the empirical results, respectively. Sections 7, 8, and 9 offer the research conclusions, policy suggestions, and limitations and suggestions for future research, respectively.

2. Literature review

The research related to this study has two main aspects: related research on the economic consequences of enterprise green transformation and related research on the influencing factors of earnings management. This section summarizes and analyzes existing literature on these two dimensions.

2.1. The economic consequences of enterprise green transformation

At the macro level, green technological innovation brought about by the green transformation of enterprises can effectively improve environmental quality by reducing carbon emissions [14], thereby promoting sustainable, healthy, and stable economic growth [15,16]. At the micro level, green corporate transformation affects corporate financing and analyst tracking.

- (1) In terms of corporate financing, Sharfman and Fernando [17] believe that corporate environmental performance can reduce corporate stock volatility, increase investor purchases, and reduce the cost of equity capital. Fatica et al. [18] find that green bonds issued by non-financial companies have a greater premium than ordinary bonds; that is, green transformation companies have lower bond issuance costs. Simultaneously, a series of green financial policies promulgated by the Chinese government, especially the green credit policy, has effectively helped green transformation enterprises obtain green credit, thereby expanding their external financing scale and easing financing constraints [19].
- (2) Existing research on external attention is relatively abundant. Chan and Walter [20] believe that companies that ignore environmental responsibilities suffer from reputational damage. Lv et al. [16] argue that green technological innovation brought about by the green transformation of enterprises can effectively improve their social reputations. To a certain extent, a company's reputation reflects its potential for future sustainable development, and analysts tend to pay more attention to companies with good growth performance [21]. Therefore, corporate green transformation can attract external attention by increasing reputation. Second, Clarkson et al. [22] find that the smaller the amount of emission data voluntarily disclosed by a company, the lower the corporate risk. Chang et al. [23] show that corporate green information disclosure can effectively reduce corporate risk by reducing information asymmetry between managers and investors. The reduction in corporate risk contributes to the sustainable development of the company in the future and can attract the attention of analysts. Green transformation can attract external attention by reducing corporate risks. Finally, Shane and Spicer [24] find that better external environmental information can effectively improve stock returns. At the same time, as investors become more aware of the potential negative consequences of corporate damage to the environment, the stock value of green transformation companies will generate a "green premium" and the market value will rise accordingly [25]. In addition, the environmental protection behavior and environmental information disclosure of green transformation enterprises will generate "green incentives," causing a "green premium" in their stock value, significantly increasing their market value [20,22,26–28]. Companies with high market capitalization can attract talent and capital more easily, which can help them gain more analyst attention. Therefore, green transformation can attract external attention by increasing enterprises' market value.

With regard to the microeconomic consequences of corporate green transformation, most current research focuses on two aspects: (1) green financial policies and the increasing financing available given the improvements in environmental performance and (2) improvements in firms' environmental protection level and the increase in external attention brought about by the improvement in the environment. However, no studies elaborate on whether the increase in financing and external attention brought about by green transformation can further optimize the quality of corporate accounting information.

2.2. Factors influencing accrual earnings management

Research on the factors influencing accrual-based earnings management is mainly conducted from the aspects of corporate financing constraints, corporate governance mechanisms, and the external market environment. In terms of the external market environment, some scholars believe that external market factors such as poor investor protection or market inefficiency promote an increase in the level of accrual-based earnings management [29,30].

- (1) At the financing constraint level, the existing literature shows that when companies face severe financing constraints, executives are more likely to change financial activities, such as achieving earnings targets through accrual earnings management, increasing the availability of external financing, and eliminating the financing constraint dilemma [31,32]. Simultaneously, when a company faces high financing needs, executives also use accrual earnings management to ensure that the company achieves relatively good performance, thereby improving creditors' evaluation of the company's solvency and making it easier for the company to obtain loans from banks [33,34].

(2) At the corporate governance level, both internal and external governance mechanisms have an impact on earnings management. In terms of internal governance mechanisms, Fan and Wong [29] believe that in enterprises with poor internal control mechanisms, large shareholders are more likely to encroach on the interests of small shareholders, and the predatory effect of this ownership structure reduces the quality of financial reports. Ashbaugh et al. [35] and El et al. [36] show that firms with internal control deficiencies have worse earnings quality than firms without deficiencies. Qian [37] contends that state-owned enterprises receive more financial and political support, which reduces their motivation for earnings management. In addition, institutional investor monitoring can reduce management's opportunistic behavior and inhibit accrual earnings management [38,39]. As an important informal institutional constraint, the reputation mechanism also restrains earnings management and other behaviors that damage the quality of accounting information [40]. In terms of external governance mechanisms, auditing, as an important external supervision mechanism, plays a key role in ensuring the quality of financial reports [41], and the professional knowledge of auditors can effectively inhibit earnings management [42]. Analysts also play a supervisory role over managers, reducing information asymmetry, improving investment efficiency, and reducing accrual-based earnings management [7,9]. At the same time, Kedia and Rajgopal [43] find that when a company is more likely to be investigated by the US Securities and Exchange Commission, its management level of accrual earnings decreases.

Regarding the micro-influencing factors of accrual earnings management, most current research focuses on two aspects: (1) the reduction in earnings management motivation brought about by the improvement of financing constraints and (2) the improvement in corporate governance, which leads to a reduction in the earnings management operation space. However, no literature elaborates on whether corporate green transformation can reduce corporate accrual earnings management by increasing financing and improving governance levels. At the same time, many investors could previously only judge the quality of a company's accounting information through its financial statements or corporate governance-related announcements. Therefore, this study provides a new method for investors to judge the quality of a company's accounting information.

2.3. Enterprise green transformation and accrual earnings management

Currently, there is limited literature on the impact of corporate green transformation on accrued earnings management. However, some studies have examined the impact of corporate participation in environmental protection activities on accrued earnings management from an environmental protection perspective.

Jiang et al. [44] show that air pollution can enhance a company's earnings management level by strengthening negative emotions among executives. Thus, when companies participate in environmental protection, they may reduce their earnings management levels by reducing negative emotions among the management. Research by Wang et al. [45] argues that the environmental protection "fee-to-tax" policy promulgated by the Chinese government can promote the green transformation of polluting enterprises through strong supervision. Strong supervision also makes companies operate more cautiously to avoid penalties from regulatory authorities, thereby reducing corporate accrual-based earnings management. Gerged et al. [46], Shang and Chi [47], and Litt et al. [48] find that in emerging or developed markets, companies that disclose more environmental information cultivate a corporate culture with ethical beliefs. Environmental information disclosure is also a manifestation of management's initiative to assume environmental responsibilities and is a "moral behavior." Therefore, managers of companies that disclose more environmental information have higher ethical standards, which reduces the unethical behavior of accrued earnings management. Zhang et al. [49] find that companies with higher ESG information disclosure tend to pay more attention to the sustainability of corporate development and long-term value. Management inhibits accrual-based earnings management to maximize corporate value, a behavior that harms stakeholders' interests. Simultaneously, according to signaling theory, increased ESG information disclosure can release positive signals to investors, ease corporate financing constraints, and reduce management incentives to manage earnings. Kolsi et al. [50] also argue that environmental responsibility is a type of social responsibility and that companies with social responsibility are less likely to engage in accrued earnings management activities.

However, a small body of literature shows that corporate participation in environmental protection activities increases the motivation for accrual-based earnings management. Brahmana et al. [51] suggest that in emerging markets, companies' environmental information disclosure increases their earnings management. Because they believe that emerging markets lack sound systems, managers can use environmental information disclosure as a corporate social responsibility activity to divert investors' attention from opportunistic behavior. Long et al. [52] find that after emissions-regulated firms implemented a carbon emissions trading scheme, an increase in compliance costs led to a decline in performance. This motivates management through self-interest, and they adopt accrual earnings management to avoid a decrease in their own compensation.

Although most studies conclude that companies' forced (e.g., environmental protection fees to tax) or proactive (e.g., environmental information disclosure, ESG information disclosure) participation in environmental activities will inhibit their earnings management level, there is still some literature that holds the opposite view. Therefore, the existing research has not yet reached a consistent conclusion regarding the relationship between corporate participation in environmental protection activities and earnings management. Therefore, the impact of corporate green transformation on accrued earnings management requires in-depth theoretical discussion and empirical testing.

3. Theoretical framework and research hypothesis

3.1. Theoretical framework

3.1.1. Information asymmetry

The theory of information asymmetry states that in market economic activities, various types of people have different understandings of relevant information; people with sufficient information are often in a more favorable position, while those with poor information are in a relatively disadvantaged position [53]. This study focuses on the theory of information asymmetry. Because managers often have more information about their companies than investors in the market, information asymmetry often exists between them. This opaque information environment provides firms with the opportunity to manipulate earnings [54,55]. The green transformation of enterprises can alleviate information asymmetry between investors and managers by strengthening a company's internal and external governance mechanisms and improving the quality of green information disclosure. When the degree of corporate information asymmetry decreases, the cost of corporate earnings management increases, which in turn reduces costs [10].

3.1.2. Principal-agent theory

Principal-agent theory is one of the main components of contract theory in institutional economics. In this case, one or more actors designate and hire other actors to serve them according to an explicit or implicit contract. The latter are awarded certain decision-making rights and pay the corresponding remuneration according to the quantity and quality of services provided by the latter [56]. The research in this study is related to the principal-agent theory because managers, as agents, may act against the interests of the principal to secure their own position or salary promotion, resulting in principal-agent problems. The green transformation of the enterprise shows the client's willingness to hope for the sustainable development of the enterprise, so the client may alleviate the principal-agent problem through contract protection and other means [57].

3.2. Research hypothesis

Through an analysis of the economic consequences of enterprise green transformation, combined with existing theories and literature, this study argues that enterprise green transformation may inhibit accrual earnings management in two ways: limiting the implementation space of accrual earnings management and eliminating the implementation motivation of accrual earnings management.

The green transformation of enterprises can limit the implementation space of accrual earnings management and restrain accrual-based earnings management. The root cause of earnings management is information asymmetry between investors and managers, and a good corporate governance mechanism can effectively alleviate information asymmetry through supervision effects, thus limiting the implementation space of accrual-based earnings management [7].

On the one hand, because banks incorporate corporate environmental information into their lending decisions, green transformation companies are encouraged to improve their green information disclosure. This reduces analysts' costs of obtaining corporate information, thereby attracting a larger analyst following [58]. At the same time, the green innovation of enterprises in green transformation can improve overall future performance by improving environmental performance [59,60], and analysts tend to pay more attention to companies with good growth performance [21]. Therefore, the sustainable development prospects of green transformation enterprises will attract more analysts to follow. On the other hand, the green technology innovation brought about by the green transformation of enterprises contributes to environmental governance. This behavior of assuming environmental responsibility is recognized by stakeholders such as the public, investment institutions, and government, and helps enterprises build a good image and obtain reputation capital [16,20,61,62]. As a special corporate governance mechanism, reputation can release positive signals to the public and reduce information asymmetry; analyst tracking can also be added. As an important external corporate governance mechanism, analysts have the motivation and ability to have a supervisory effect on the company and reduce information asymmetry by carefully reviewing public information disclosures [63], thus effectively suppressing accrual earnings management levels [9,10].

The green transformation of enterprises can eliminate or restrain managers' motivation to implement accrual-based earnings management. The green transformation of enterprises can alleviate debt financing motivation for accrual-based earnings management. At the level of equity financing, green transformation companies improve their overall performance in the future by improving their environmental performance [59], and the green information disclosure of green transformation companies reduces the information asymmetry between managers and investors [9]; thus, investors can obtain company information at a lower cost, increase the market's willingness to invest in it, push up stock prices, reduce equity financing costs [17], and increase corporate equity financing. At the debt financing level, green transformation send a positive signal to the market, reducing their risk of violating environmental laws and regulations [64], enabling them to issue green bonds with a greater premium, thereby reducing their bond issuance costs [18] and increasing the scale of direct financing of enterprises. Simultaneously, the Chinese government promulgated a series of green credit policies in recent years, enabling banks to incorporate corporate environmental information into their lending decisions [65]. Green transition enterprises send positive signals to banks, making it easier to obtain bank credit at lower loan interest rates and increasing the scale of indirect financing. Even companies with high financing constraints pay attention to the long-term impact of green credit policies on their financing and actively carry out green transformation to ease financing constraints [19]. Relieving corporate financing constraints can effectively inhibit executives' motivation to increase external financing through earnings management, thereby reducing accrual-based earnings management [31–34].

Based on the above analysis, the following research hypothesis is put forward.

H1a. All else unchanged, corporate green transformation is negatively correlated with accrual-based earnings management.

Giuli et al. [13] believe that green transformation, as part of corporate social responsibility, will increase a company’s sales, general, and administrative expenses (SG&A), and indirectly reduce the company’s profitability. At the same time, owing to the impact of externalities, enterprises undergoing green transformation must bear the cost of green innovation but cannot enjoy all the benefits of green transformation [66]. In addition, Min [67] believes that the economic benefits of corporate green transformation lag and the risk of failure is high. This creates high costs during the green transformation period, which may impact their profitability in the short term. According to the “rational person” hypothesis, investors, as rational people, will reduce their investment in the company when the profitability of the company declines, causing the company’s stock price to fall. A decrease in stock prices may have negative effects on managers, such as salary cuts and job demotions. To prevent a decline in stock prices from negatively affecting their own interests, management may avoid damaging their own private interests through accrual earnings management [68].

Based on the above analysis, this study investigates the following hypotheses.

H1b. All else unchanged, corporate green transformation is positively related to accrual-based earnings management.

4. Research design

4.1. Sample selection and data sources

This study selected A-share listed companies in China from 2015 to 2021 as the research sample. Chinese companies were chosen primarily because China, one of the largest emerging markets, has introduced a series of policies to encourage enterprises to go green. The sample period begins in 2015, because the China Banking Regulatory Commission issued the “Green Credit Guidelines” in 2012, and promulgated the “Key Evaluation Indicators for the Implementation of Green Credit” in 2014, which made the green transformation of Chinese listed companies more and more active after 2015. Referring to previous research practices, the sample data were processed as follows: (1) eliminate samples with missing financial indicators, (2) eliminate insolvent samples, (3) eliminate financial industry samples, (4) eliminate ST and ST* firms, and (5) overcome the influence of outliers on the regression results by winsorizing continuous variables at the upper and lower 1 % levels. A total of 15,032 annual samples were collected from 2015 to 2021. Enterprise green transformation data come from the annual reports of various listed companies, other financial data come from the CSMAR and Wind databases, and industry classification data come from the industry classification standards published by Shenying & Wanguo.

4.2. Variable definitions

4.2.1. Dependent variable

The dependent variable was accrual-based earnings management. Following Dechow et al. [69], the modified Jones model was used to calculate accrual earnings management. The specific calculation method is shown in Equation (1).

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_{1,i} \frac{1}{A_{i,t-1}} + \alpha_{2,i} \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{A_{i,t-1}} + \alpha_{3,i} \frac{PPE_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t}, \tag{1}$$

where $TA_{i,t}$ represent the total accrued profit, which is the net profit minus the net cash flow of operating activities; $A_{i,t-1}$ represents the total assets at the end of the year; $\Delta REV_{i,t}$ represents the increase in operating income; $\Delta REC_{i,t}$ represents the increase in net

Table 1
Variable definitions.

variable classification	variable name	variable symbol	variable specification
Dependent Variable	Accrual Earnings Management	DA	Referring to Dechow et al. (1995), accrual earnings management indicators constructed using the modified Jones model
Independent Variable	Enterprise Green Transformation	GT	Constructed using the text analysis method, see the above for the specific calculation method
Control Variable	Size of the Enterprise	Size	The logarithm of the number of employees in the enterprise
	Asset-Liability Ratio	Lev	Total Liabilities/Total Assets
	Return on Assets	ROA	Net profit/total assets
	shareholding ratio of the largest shareholder	Top1	Shareholding ratio of the largest shareholder
	market value Book-to-book ratio	MB	Market Value/Total Assets
	operating income growth rate	Growth	(Operating income - operating income of the previous period)/Operating income of the previous period
	company age	Age	The logarithm of the establishment year plus 1
	board size	Bsize	The logarithm of the total number of directors
	proportion of independent directors	Ind	Number of independent directors/total number of directors
	controlling shareholder separation of two rights	Wedge	The difference between controlling shareholder’s control right and cash flow right
dual-job integration	Duality	If the two positions of CEO and chairman are combined, the value is 1, otherwise it is 0	

accounts receivable; $PPE_{i,t}$ represents Fixed assets, i indicating the company, t indicating the year. Model (1) is estimated for each industry and financial year and define the regression residual as the controllable accrual item $DA_{i,t}$, which represents the current abnormal accrual profit after adjusting for total assets at the end of the previous period. The absolute value $|DA_{i,t}|$ is used as a proxy for earnings quality. A larger $|DA_{i,t}|$ means a higher level of earnings management, and a smaller $|DA_{i,t}|$ means a lower level of accrual earnings management and better earnings quality.

4.2.2. Independent variable

Drawing on Loughran et al. [70], text information disclosed in the annual reports of listed companies was used to measure the green transformation of enterprises. Green transformation is very important strategic information for listed companies in China, as disclosed in the annual report. This study selects 113 keywords (specific keywords can be found in Appendix A) for the green transformation of enterprises from five aspects: publicity initiative, strategic concept, technological innovation, sewage treatment, and monitoring management. We then counted the frequency of each keyword appearing in the annual report text of listed companies to form the frequency of green transformation words and used the word frequency plus 1 to take the natural logarithm to describe the green transformation of enterprises.

4.2.3. Control variable

As in prior studies [10,30,71], the control variables include the size of the enterprise (Size), asset-liability ratio (Lev), return on assets (ROA), shareholding ratio of the largest shareholder (Top1), market value Book-to-book ratio (MB), operating income growth rate (Growth), company age (Age), board size (Bsize), proportion of independent directors (Ind), controlling shareholder separation of two rights (Wedge), dual-job integration (Duality), industry, province and year dummy variables. Table 1 presents the main variables and their descriptions.

4.3. Empirical model

To verify the impact of corporate green transformation on accrual-based earnings management, a model such as equation (2) is constructed.

$$|DA_{i,t}| = \alpha_0 + \alpha_1 GT_{i,t} + \sum \beta_k Control_{i,t}^k + Year + Industry + Province + \varepsilon_{i,t}, \quad (2)$$

where $|DA_{i,t}|$ is the accrual earnings management index calculated according to formula (1); the larger the index, the higher the degree of accrual earnings management. $GT_{i,t}$ is an indicator of the degree of green transformation of an enterprise constructed using text analysis. The larger the index, the higher is the degree of green transformation of the enterprise. $\sum Control_{i,t}^k$ are the control variables listed in Table 1. *Year*, *Industry*, and *Province* are fixed effects of year, industry and province respectively, and $\varepsilon_{i,t}$ is a random error term. In addition, to address the influence of factors such as cross-sectional correlation and eliminate heteroscedasticity, cluster correction on the standard error is performed at the individual level.

5. Analysis of empirical results

5.1. Analysis of descriptive statistics results

Table 2 reports descriptive statistics for the main variables. The mean value of $|DA|$ is 0.049, the median is 0.030. The minimum value of $|DA|$ is 0, and the maximum value is 0.930, indicating large differences in accrual earnings management among different enterprises. The mean value of GT is 3.080, the standard deviation is 0.997, the minimum value is 0, and the maximum value is 7.143; that is, during the sample period, the keywords of corporate green transformation appear in the annual report at least 0 times and at most 1264 times. Hence, there are significant differences in the degree of corporate green transformation among different companies, which may be because different companies have different awareness and implementation of corporate green transformation. The results for the other control variables are within a reasonable range [30]. In addition, a mean t -test was performed on the samples according to the median grouping of green transformation. The detailed results are shown in Appendix B.

Table 3 shows the correlation coefficient results. In the Pearson correlation coefficient matrix, the correlation coefficient between corporate green transformation and accrual earnings management is -0.11 , which is significant at the 1 % level. Spearman's correlation coefficient matrix results show that the correlation coefficient between corporate green transformation and accrual earnings management is -0.10 , which is also significant at the 1 % level. The results show that, without considering the influence of other factors, there is a negative correlation between corporate green transformation and accrual-based earnings management. In other words, green transformation inhibits accruals earnings management to a certain extent. The largest value in the correlation coefficient table was 0.40, indicating that there were no multicollinearity problems.

5.2. Enterprise green transformation and earnings management

Table 4 presents the regression results for corporate green transformation and accrual-based earnings management. After

Table 2
Descriptive statistics.

VarName	Obs	Mean	SD	Median	P25	P75	Min	Max
GT	15,032	3.080	0.997	3.045	2.303	3.784	0.000	7.143
DA	15,032	0.049	0.065	0.030	0.011	0.062	0.000	0.930
Size	15,032	7.768	1.193	7.727	6.975	8.529	4.543	11.290
Lev	15,032	0.434	0.202	0.426	0.276	0.581	0.060	0.895
ROA	15,032	0.027	0.075	0.032	0.010	0.060	-0.332	0.197
Top1	15,032	32.158	14.318	29.950	21.070	41.280	8.450	72.880
MB	15,032	2.160	1.481	1.687	1.243	2.482	0.845	9.448
Growth	15,032	0.159	0.397	0.099	-0.033	0.260	-0.569	2.335
Age	15,032	2.991	0.273	2.996	2.833	3.178	2.197	3.526
Bsize	15,032	2.263	0.297	2.303	2.079	2.485	1.386	2.944
Ind	15,032	39.298	7.103	37.500	33.333	42.857	33.333	62.500
Wedge	15,032	0.232	0.120	0.222	0.138	0.315	0.030	0.557
Duality	15,032	0.258	0.438	0.000	0.000	1.000	0.000	1.000

controlling the year, province, and industry fixed effects in Column (1), the regression coefficient of corporate green transformation and accrual earnings management is -0.006 , which is significant at the 1 % level. After adding the other company-level control variables in Column (2), the regression coefficient between corporate green transformation and accrual-based earnings management is -0.002 , which is significant at the 5 % level. This shows that green transformation has an inhibitory effect on earnings management, and enterprises with higher degrees of green transformation have lower degrees of earnings management, verifying H1a. For the regression, the sample is divided into positive earnings management ($DA > 0$) and negative earnings management ($DA < 0$). Columns (3) and (4) show the results. The regression coefficient of corporate green transformation and positive earnings management is -0.003 , which is significant at the 5 % level. The regression coefficient with negative earnings management is -0.001 , which is not significant. Simultaneously, this study uses Fisher's combination test and bootstrapping to conduct 3000 sampling tests on the differences in coefficients between groups. The empirical P value was 0.003, which is significant at the 1 % level. This shows that corporate green transformation effectively inhibits positive earnings management but has no significant impact on negative earnings management.

5.3. Endogeneity control

Corporate green transformation can inhibit earnings management; however, companies with low earnings management may promote corporate green transformation through good governance. Therefore, to alleviate possible endogeneity problems, the "Environmental Protection Tax Law of the People's Republic of China" promulgated and implemented by the Chinese government in 2018 was regarded as an exogenous policy impact, and PSM-DID was used to alleviate possible endogeneity problems.

To protect and improve the environment, reduce pollutant emissions, and promote the sustainable development of the green economy, the Chinese government issued the "Environmental Protection Tax Law of the People's Republic of China" in 2018. This was China's first single-line tax law that aimed at environmental protection and specifically embodied the "green tax system." Previously, China had long adopted a sewage charging system for corporate pollution, and the emergence of the "Environmental Protection Tax Law" means that the government has begun to use legal authority to guide companies to participate in environmental governance. When an enterprise delays payment, refuses to pay, or bears excessively high taxes for a long time, the government and relevant departments impose targeted penalties that seriously affect the enterprise's ability to obtain government resources. Therefore, the supervision and punishment pressure brought by the "Environmental Protection Tax Law" will force enterprises to save energy, reduce emissions, and optimize economic structure [72,73], thereby promoting the green transformation of enterprises.

In the actual process of collecting environmental protection taxes, the state sets only upper and lower limits on environmental protection tax rates. Local governments can independently determine tax rates based on local environmental conditions and enterprises' ability to bear the tax burden. During the implementation of the environmental protection tax policy, some provinces used the original sewage fee collection standard as the environmental protection tax amount standard (i.e., "tax burden shift"). Further, the 12 provinces of Hebei, Henan, Jiangsu, Shandong, Hunan, Sichuan, Chongqing, Guizhou, Hainan, Guangxi, Shanxi, and Beijing raised their tax standards ("tax burden increase"). Therefore, in this study, enterprises located in tax-burden-increasing areas are regarded as the experimental group and those located in tax-burden-shifting areas are regarded as the control group. The environmental protection tax was implemented in January 2018. This study takes the period before 2018 as before policy implementation and the period after 2018 (including 2018) as after policy implementation. Equation (3) was constructed to conduct DID analysis.³

$$|DA_{i,t}| = \alpha_0 + \alpha_1 Treatment_{i,t} * After_{i,t} + \sum \beta_k Control_{i,t}^k + Year + Industry + Province + \varepsilon_{i,t}, \quad (3)$$

³ The selection of environmental protection "fee to tax" as the external impact of corporate green transformation is based on the following two reasons: First, the environmental protection "fee to tax" reform is unlikely to be driven by earnings management. Secondly, the degree of green transformation of enterprises located in areas with "increased tax burdens" has changed significantly before and after the environmental protection "fee-to-tax" reform. The DID of this paper tests whether corporate green transformation is related to a decline in earnings management.

Table 3
Variable correlation coefficient test results.

	GT	DA	Size	Lev	ROA	Top1	MB	Growth	Age	Bsize	Ind	Wedge	Duality
GT	1	-0.10***	0.22***	0.13***	0.03***	0.04***	-0.26***	0.03***	0.12***	0.10***	-0.06***	-0.06***	-0.07***
DA	-0.11***	1	-0.14***	0.10***	-0.14***	-0.08***	0.06***	-0.01	0.01	-0.00	-0.01	0.01	0.01
Size	0.22***	-0.18***	1	0.34***	0.11***	0.17***	-0.33***	0.08***	0.05***	0.16***	-0.05***	-0.03***	-0.11***
Lev	0.12***	0.13***	0.32***	1	-0.39***	0.06***	-0.40***	-0.01	0.17***	0.14***	-0.04***	-0.10***	-0.09***
ROA	0.05***	-0.36***	0.13***	-0.32***	1	0.14***	0.24***	0.32***	-0.07***	-0.06***	0.02**	0.10***	0.02***
Top1	0.04***	-0.09***	0.19***	0.07***	0.16***	1	-0.12***	0.01	-0.01	-0.02**	0.00	-0.40***	-0.04***
MB	-0.23***	0.07***	-0.29***	-0.29***	0.12***	-0.08***	1	0.06***	-0.21***	-0.12***	0.13***	0.06***	0.11***
Growth	-0.01	0.03***	0.03***	0.01	0.23***	0.01	0.03***	1	-0.07***	-0.05***	-0.04***	0.10***	0.04***
Age	0.12***	0.03***	0.03***	0.17***	-0.04***	-0.02**	-0.11***	-0.05***	1	0.14***	-0.05***	-0.11***	-0.11***
Bsize	0.10***	0.01	0.16***	0.14***	-0.05***	-0.01	-0.08***	-0.02**	0.13***	1	-0.12***	0.01	-0.09***
Ind	-0.06***	-0.00	-0.04***	-0.04***	0.03***	0.01	0.13***	-0.03***	-0.05***	-0.14***	1	-0.02***	0.02***
Wedge	-0.06***	0.02***	-0.01	-0.11***	0.05***	-0.42***	0.03***	0.11***	-0.11***	0.01	-0.03***	1	0.06***
Duality	-0.07***	0.01	-0.11***	-0.09***	-0.01	-0.04***	0.06***	0.03***	-0.11***	-0.09***	0.02***	0.05***	1

***p < 0.01, **p < 0.05, *p < 0.1. Below the main diagonal is the Pearson correlation matrix, and above the main diagonal is the Spearman correlation matrix.

Table 4
Regression results of corporate green transformation and accrual earnings management.

	(1)	(2)	(3)	(4)
	DA	DA	DA (DA>0)	DA (DA<0)
GT	-0.006*** (-5.91)	-0.002** (-2.03)	-0.003** (-2.14)	-0.001 (-0.86)
Size		-0.007*** (-7.53)	-0.013*** (-10.26)	-0.003*** (-3.55)
Lev		0.021*** (4.61)	0.061*** (9.29)	0.007 (1.32)
ROA		-0.317*** (-21.30)	0.175*** (7.09)	-0.443*** (-28.67)
Top1		0.000 (0.06)	-0.000 (-1.49)	0.000 (0.48)
MB		0.005*** (5.46)	0.001 (0.78)	0.005*** (4.48)
Growth		0.018*** (8.12)	0.013*** (3.97)	0.019*** (8.13)
Age		0.005* (1.74)	0.006* (1.70)	0.004 (1.05)
Bsize		0.004* (1.94)	0.001 (0.38)	0.007*** (2.80)
Ind		0.000 (0.84)	0.000 (0.67)	0.000 (0.37)
Wedge		0.017*** (2.68)	0.015* (1.74)	0.006 (0.82)
Duality		-0.001 (-0.73)	-0.001 (-0.47)	-0.000 (-0.18)
_cons	0.056*** (5.75)	0.058*** (4.67)	0.083*** (5.12)	0.044*** (3.08)
Empirical p-value			0.003	
Industry FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	15,032	15,032	7377	7655
Adj. R2	0.04	0.20	0.11	0.38

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

where *Treatment* is a dummy variable for the experimental and control groups. If it is the experimental group (an enterprise located in an area where the tax burden is increasing), then *Treatment* is 1; if it is the control group (an enterprise located in an area where the tax burden is shifting), then *Treatment* is 0. *After* is a dummy variable for the time before and after the policy; if it is before 2018, then *After* is 0; if it is after 2018, then *After* is 1. Enterprise green transformation is expected to inhibit earnings management, and this study predicts that the sign of the regression coefficient of the interaction item will be negative.

In this study, repeatable 1:1 nearest-neighbor matching was used to process the samples using PSM. Table 5 presents the results of the PSM balance test. The results show that the absolute value of the standard deviation of each matching variable after matching was < 5 %. The balance test results show that the matching meets the balance assumption, that is, the variables involved in the matching and the matching methods used are appropriate.

The results of the PSM-DID are presented in Table 6. After removing unmatched enterprise data, the coefficient of the interaction term is -0.008 when Column (1) only controls for industry fixed effects, which is significant at the 1 % level, and Column (2) only controls for industry, year, and province fixed effects. In this case, the interaction coefficient is -0.008, which is significant at the 1 % level. After the control variables at the enterprise level are added in column (3), the interaction coefficient is -0.008, which is significant at the 1 % level. Therefore, after mitigating possible endogeneity, corporate green transformation can effectively suppress accrual-based earnings management, supporting previous conclusions.

A prerequisite for unbiased estimation results of the DID method is that the parallel trend assumption is satisfied between the experimental and control groups. To verify the parallel trend assumption, the event study method (Event-Study) is used to build equation (4) for parallel trend testing:

$$|DA_{i,t}| = \alpha_0 + \sum_t \delta_t (Treatment_i \times Year_t) + Year + Industry + Province + \epsilon_{i,t} \tag{4}$$

The first period before the policy was implemented is used as a baseline for the model. The results are shown in Column (4) of Table 6 and Fig. 2. The coefficients of pre3 and pre2 are not statistically significant. It shows that there is no significant difference between the pretreatment group and the control group of the environmental protection policy “fee to tax reform,” and the parallel trend hypothesis is established.

To reduce the biased estimation results caused by omitted variables, the robustness of the DID model was further checked through a Placebo Test. By randomly constructing a “pseudo-experiment group,” generating pseudo-policy dummy variable interaction items,

Table 5
PSM balance test.

Variable	Unmatched/Matched	Mean		%bias	%reduct bias	t-test	
		Treated	Control			t	p> t
Size	U	7.752	7.789	-3.1	82.4	-1.88	0.060
	M	7.752	7.746	0.5		0.36	0.720
Lev	U	0.434	0.434	-0.1	-5.0	-0.06	0.950
	M	0.434	0.433	0.1		0.07	0.943
ROA	U	0.027	0.026	1.4	-26.3	0.86	0.391
	M	0.027	0.028	-1.8		-1.19	0.232
Top1	U	31.984	32.391	-2.8	98.8	-1.72	0.085
	M	31.984	31.979	0.0		0.02	0.982
MB	U	2.178	2.136	2.9	95.5	1.73	0.083
	M	2.178	2.180	-0.1		-0.08	0.933
Growth	U	0.160	0.157	0.7	-167.1	0.45	0.656
	M	0.160	0.168	-2.0		-1.28	0.200
Age	U	2.996	2.984	4.4	97.0	2.66	0.008
	M	2.996	2.997	-0.1		-0.09	0.929
Bsize	U	2.256	2.271	-5.2	73.9	-3.15	0.002
	M	2.256	2.260	-1.4		-0.88	0.376
Ind	U	39.391	39.175	3.0	37.5	1.84	0.065
	M	39.391	39.256	1.9		1.25	0.213
Wedge	U	0.235	0.229	5.0	97.9	3.02	0.003
	M	0.235	0.235	0.1		0.07	0.946
Duality	U	0.274	0.237	8.4	90.8	5.08	0.000
	M	0.274	0.278	-0.8		-0.49	0.621

Table 6
PSM-DID robustness test.

	(1)	(2)	(3)	(4)
	DA	DA	DA	DA
pre3				-0.001 (-0.29)
pre2				0.003 (0.82)
current				-0.007* (-1.78)
post1				-0.008** (-1.98)
post2				-0.007* (-1.87)
post3				-0.009** (-2.17)
Treatment*After	-0.008*** (-3.66)	-0.008*** (-3.63)	-0.008*** (-3.80)	
After	0.002 (1.08)			
Treatment	-0.001 (-0.39)			
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Province FE	No	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes
N	12,719	12,719	12,719	12,719
Adj. R2	0.03	0.03	0.20	0.20

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

regressing according to model (3), and judging the reliability of the sample-based analysis based on the probability distribution of the estimated coefficients of the interaction items in the regression model. To enhance the effectiveness of the placebo test, after 500 repetitions, the estimated coefficient distribution of the pseudo-policy dummy variable interaction item was drawn as shown in Fig. 3. It can be seen that most of the estimated coefficient distribution of the interaction item is concentrated around the zero value. This shows that the model setting does not omit important variables, and that the regression results of DID are not caused by random factors, which proves that the conclusion of DID is robust.

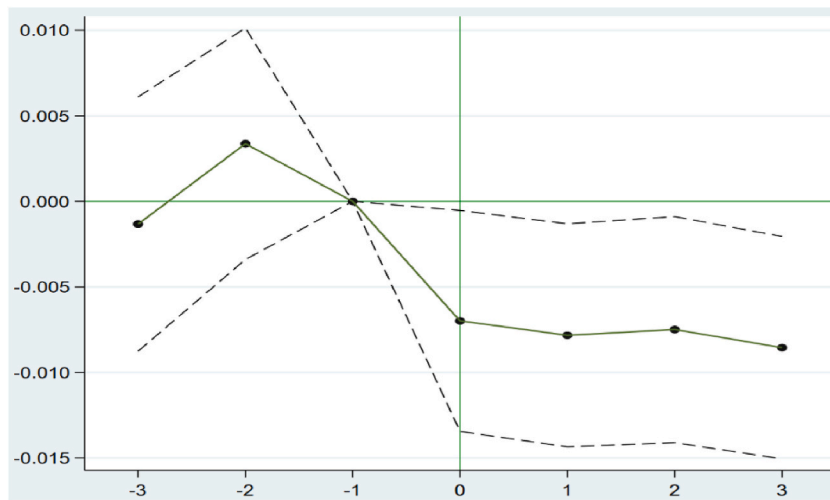


Fig. 2. Parallel trend test.

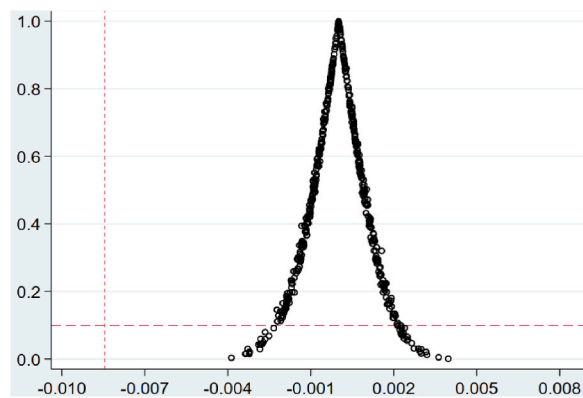


Fig. 3. Placebo test.

5.4. Heterogeneity test

Scientific and technological innovation capabilities form the basis for the sustainable development of enterprises. Companies with high-tech technologies are more likely to rely on technological innovations to drive corporate green transformation. Life cycle theory posits that the formation and development of enterprises have life forms, and enterprises in different life cycles are almost the same in terms of development strategy, capital demand, and financing constraints. Therefore, the impact of corporate green transformation on accrued earnings management may be heterogeneous, depending on whether the company is a high-tech enterprise or its lifecycle.

First, the inhibitory effect of corporate green transformation on earnings management may be heterogeneous, depending on whether the company is high tech. Compared to traditional enterprises, high-tech enterprises have a higher output value of high-tech products, more patents, and scientific and technical personnel and are an important part of the high-quality development of the urban economy. To promote the transformation and upgrade of industrial structures, the Chinese government implemented policy support for high-tech enterprises, such as tax reduction and exemption, national scientific research funding support, financial allocation, and priority improvement of corporate office land. Therefore, enterprises can use subsidies provided by the policy to accelerate green transformation by combining advanced technologies with scientific research personnel. This study predicts that, compared to non-high-tech enterprises, the green transformation of high-tech enterprises has a stronger inhibitory effect on earnings management. Therefore, this section divides the sample into high-tech and non-high-tech enterprises, according to the CSMAR database of China's listed company qualification accreditation research database. The results are shown in Columns (1) and (2) of Table 7. The regression coefficient between the green transformation of enterprises and the earnings management of non-high-tech enterprises is -0.001 but not significant, and the regression coefficient with the earnings management of high-tech enterprises is -0.003 , which is significant at the 1 % level. In this study, Fisher's combination test and bootstrapping were used to conduct 3000 sampling tests on the differences in coefficients between the groups. The empirical P value was 0.007, which is significant at the 1 % level. The results indicate that the inhibitory effect of green transformation on earnings management is more significant for high-tech enterprises.

Table 7
Heterogeneity test.

	(1)	(2)	(3)	(4)	(5)
	High-tech enterprises	Non-high-tech enterprises	Growth-stage enterprise	Mature-stage enterprise	Recession-stage enterprise
GT	−0.003*** (−3.47)	−0.001 (−0.67)	−0.003*** (−2.71)	−0.002* (−1.67)	0.001 (0.40)
Controls	Yes	Yes	Yes	Yes	Yes
Empirical p-value	0.007				
Empirical p-value			0.047		
Growth-stage and Mature-stage					
Empirical p-value			0.003		
Growth-stage and Recession-stage					
Empirical p-value				0.030	
Mature-stage and Recession-stage					
Industry FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	7758	7274	6155	5508	3364
Adj. R2	0.25	0.16	0.15	0.29	0.17

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

Second, the suppression of earnings management through corporate green transformation may differ among companies across their life cycles. Compared with companies in the growth stage, companies have a higher degree of internal and external information asymmetry, have difficulty raising external funds, and are more motivated to go green and transform to alleviate information asymmetries with investors and obtain more bank credit. Companies in their mature stages must detect changes in the market environment in a timely manner. Companies in their mature stage may transition to green policies because of their emphasis on sustainable development. Therefore, green transformation is expected to have the strongest inhibitory effect on earnings management during the growth stage. Referring to Dickinson [74], enterprises are divided into growth, maturity, and decline periods based on the signs of net cash flows from operating, investing, and financing activities. In the growth stage, the net cash flow from the operating activities of an enterprise is positive, the net investment cash flow is negative, and the net cash flow from financing activities is positive. In the mature stage, the net cash flow from the operating activities of an enterprise is positive, the net cash flow from investing activities is negative, and the net cash flow from financing activities is negative. The rest are enterprises in a recession. The regression results are shown in Columns (3)–(5) of Table 7. The regression coefficient of corporate green transformation and corporate earnings management in the growth stage is −0.003, which is significant at the 1 % level. The regression coefficient of corporate earnings management in the mature stage is −0.002, which is significant at the 10 % level. The regression coefficient between corporate green transformation and corporate earnings management during a recession is 0.001 but not significant. Fisher's combination test and bootstrapping were used to conduct 3000 sampling tests on the difference in coefficients between groups. It was found that the green transformation of growth-stage companies had the strongest inhibitory effect on earnings management. Additionally, the green

Table 8
Robustness test.

	(1)	(2)	(3)	(4)	(5)	(6)
	DA2	DA3	DA4	DA	DA	DA
GT	−0.002** (−1.99)	−0.002* (−1.94)	−0.002* (−1.89)			
GP				−0.001** (−2.35)		
GIP					−0.002*** (−2.66)	
ESG_Score						−0.024** (−1.99)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	15,032	15,032	15,032	15,032	15,032	15,032
Adj. R2	0.20	0.20	0.20	0.20	0.20	0.20

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

transformation of enterprises in the mature stage has a strong inhibitory effect on earnings management.

5.5. Robustness test

To ensure the robustness of the previous conclusions, this study conducted a robustness test on the benchmark regression from multiple angles.

First, the measurement index was replaced with accrual-based earnings management. In the robustness test, three methods are used to measure corporate accrual-based earnings management. First, as in Jones [75], the results using the Jones model to measure accrual earnings management are shown in Column (1) of Table 8. The coefficient of GT is significantly negative at the 5 % level. Second, referring to Dechow et al. [68], only time-series data were used to estimate and correct the parameters in the Jones model. The results are shown in Column (2) of Table 8. The coefficient of GT was significantly negative at the 10 % level. Finally, referring to the approach of Kothari et al. [76], ROA is placed into the modified Jones model as a control variable to control for the impact of performance, a constant term is added to the model, and the modified Jones model is used to measure accrual-based earnings management. The results are shown in Column (3) of Table 8, where the coefficient of GT is significantly negative at the 10 % level.

Second, the measurement indicators of green transformation were replaced. The robustness test used three alternative methods to measure enterprises' green transformation. Following Wu et al. [77], this study added one to the logarithm of the number of corporate green patent applications, constructed the green transformation index (GP), and substituted it into the baseline model regression. The results are shown in Column (4) of Table 8. The coefficient of GP was significantly negative at the 5 % level. Second, Min [67] contends that, compared with utility model patents, invention patents can better reflect the innovation capabilities of enterprises and thus better reflect the effects of corporate green transformation. This study added one to the logarithm of the number of green invention patent applications, constructed the green transformation index (GIP), and substituted it in the baseline model regression. The results are shown in Column (5) of Table 8. The GIP coefficient is significantly negative at the 1 % level. Finally, Zhong et al. [78] reported that corporate ESG performance sends a positive signal of green transformation to the market. This study uses the comprehensive ESG scores of listed Huazheng companies as the green transformation indicator, ESG_Score, and substitutes it into the benchmark model regression. The results are shown in Column (6) of Table 8. The coefficient of ESG_Score was significantly negative at the 5 % level.

Third, we consider model transformation. The explanatory and explained variables in this study are data at the enterprise level and clustered at the individual level. However, considering that enterprises in the same city inevitably compete and cooperate, and thus influence each other, this study re-clusters the regression results to the prefecture-level city level. The results are shown in Column (1) of Table 9. The coefficient of GT was significantly negative at the 10 % level. This study changes the dimension of fixed effects by replacing industry and province fixed effects with enterprise fixed effects. The results are shown in Column (2) of Table 9. The coefficient of GT was significantly negative at the 5 % level.

Fourth, this study added a one-period lag. The impact of green transformation on earnings management may also be delayed. This study regresses the explanatory variable green transformation and all the control variables with a lag of one period. The results are shown in Column (3) of Table 9. The coefficients of GT are all significantly negative at the 5 % level, verifying the robustness of this study.

Finally, the sampling intervals were replaced. The sample period is from 2015 to 2021. Since the end of 2019, China has been hit by the COVID epidemic, which had a negative impact on the development of enterprises and will have an impact on the green transformation and earnings management of enterprises. To avoid the impact of the pandemic on the regression results, samples were removed and regressed for 2020 and 2021. The results are shown in Column (4) of Table 9. The coefficients of GT are all significantly negative, at least at the 10 % level, verifying the robustness of this study.

5.6. Mechanism test

Effectively restraining accrual-based earnings management must be discussed from two perspectives. On the one hand, a strong corporate governance mechanism is needed to reduce the implementation space of earnings management; on the other hand, it is

Table 9
Other robustness tests.

	(1)	(2)	(3)	(4)
	DA	DA	DA	DA
GT	-0.002* (-1.83)	-0.003** (-2.03)	-0.002** (-2.30)	-0.002* (-1.95)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	Yes
Province FE	Yes	No	Yes	Yes
Firm FE	No	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
N	15,032	15,032	11,997	10,618
Adj. R2	0.20	0.13	0.08	0.19

Note: The t value or z value is output in parentheses, the standard error is adjusted by company-level clustering; the standard error in column (1) is adjusted by prefecture-level city level clustering; ***p < 0.01, **p < 0.05, *p < 0.1.

necessary to analyze the motivation of earnings management and eliminate the motivation for implementing earnings management. Therefore, the possible mechanisms by which corporate green transformation inhibits accrual-based earnings management include the following.

- (1) Corporate green transformation increases analyst tracking, compresses the implementation space for earnings management, and reduces accrual-based earnings management.
- (2) The green transformation of enterprises eases financing constraints, reduces management motivation for earnings management, and reduces accrual-based earnings management.

This study empirically tested the above mechanism. Drawing on the idea of examining influence channels from Dessaint et al. [79], this study first examined the impact of corporate green transformation on analyst tracking and financing constraints. Then, the impact of corporate green transformation on accrual earnings management was examined in terms of analyst tracking and financing constraints for the high and low groups.

5.6.1. Analyst tracking

Corporate green transformation can attract analysts by increasing corporate green information disclosure, improving environmental performance [58,59], and reducing corporate earnings management through the monitoring effect of analysts [10]. Therefore, green corporate transformation has a greater inhibitory effect on earnings management for companies with a high analyst following. To examine this influence channel, this article refers to Yu [10] defines analyst tracking as the number of institutions (brokers) publishing profit forecast reports. Column (1) of Table 10 shows the impact of the CGT on analyst tracking. The coefficient of GT is significantly negative at the 1 % level, indicating that corporate green transformation helps attract more analysts. Columns (2) and (3) present the results of the analyst tracking test as a mechanism of action. The suppression of earnings management through corporate green transformation was greater in the group with greater analyst tracking. The regression coefficient was -0.003 and was significant at the 1 % level. Fisher's combination test showed that the difference between groups was significant at the 5 % level. This result indicates that the more analysts follow, the stronger the negative impact of corporate green transformation on earnings management. Analyst tracking is an important channel for corporate green transformations to restrain earnings management.

5.6.2. Financing constraints

The green transformation of enterprises can alleviate financing constraints by improving environmental performance; increasing green information disclosure [9,59]; reducing equity financing costs and bond issuance costs [17,18]; and increasing the scale of bank credit [19]. The relief of corporate financing constraints inhibits executives' incentives to increase external financing through earnings management, thereby easing it [34]. Therefore, green corporate transformation has a greater inhibitory effect on earnings management for companies with fewer financing constraints. To examine this influence channel, this study refers to Whited and Wu [80] and uses the WW index to measure financing constraints. Column (1) of Table 11 shows the impact of the CGT on financing constraints. The coefficient of GT is significantly negative at the 1 % level, indicating that green corporate transformation helps alleviate financing constraints. Columns (2) and (3) give the test results for financing constraints as an action mechanism. The inhibitory effect of corporate green transformation on earnings management is greater in groups with fewer financing constraints. The regression coefficient was -0.003 , which was significant at the 1 % level. Fisher's combination test showed that the difference between the groups was significant at the 1 % level. This result indicates that the lower the financing constraints, the stronger the negative impact of corporate green transformation on earnings management. Financing constraints are an important channel through which corporate green transformation restrains earnings management.

5.7. Further discussion

Enterprises' green transformations can effectively inhibit accrual-based earnings management. Managers have two choices when faced with green transformation governance. One option is that managers work hard to improve the company's earnings disclosure level and earnings quality under the governance of green transformation, reducing the possibility of financial fraud in the company, and fully reflecting the governance role of green transformation. The other is the opposite: green transition forces managers from accrual to real earnings management, and the latter causes greater damage to company value [81].

From a theoretical perspective, on the one hand, the green transformation may not eliminate managers' motivation for earnings management when it inhibits corporate accrual earnings management by increasing the number of analysts to follow. This leads managers to ostensibly reduce accrual earnings management and adopt more covert real earnings management [82] to achieve their earnings targets. On the other hand, green transition suppresses accrual earnings management by relieving financing constraints and

Table 10
Mechanism test of analyst tracking.

	(1)	(2)	(3)
	Analysts	Analysts_High	Analysts_Low
GT	0.316*** (2.88)	-0.003*** (-2.83)	-0.001 (-0.60)
Controls	Yes	Yes	Yes
Empirical p-value		0.013	
Industry FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	15,032	7185	7847
Adj. R2	0.38	0.11	0.24

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

Table 11
Mechanism test of financing constraints.

	(1)	(2)	(3)
	WW_Index	WW_High	WW_Low
GT	-0.003*** (-4.62)	-0.001 (-0.57)	-0.003*** (-2.61)
Controls	Yes	Yes	Yes
Empirical p-value		0.003	
Industry FE	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	14,983	7492	7491
Adj. R2	0.68	0.27	0.11

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

These results show that analyst tracking and financing constraints are the mechanisms through which corporate green transformation affects earnings management. The conduction path is "enterprise green transformation → Increase analyst follow-up/reduce financing constraints → restrain earnings management."

eliminates managers' motivation for earnings management, which is likely to enable managers to improve the quality of accounting information while reducing real earnings management.

To explore the impact of green transformation on earnings management and whether it will prompt management to shift from accrual to real earnings management, this study refers to Roychowdhury [83] and used abnormal cash flows from operating activities (DCFO), abnormal expenses (DDISEXP), abnormal product costs (DPROD), and constructed a comprehensive index (REM) using the above three indicators to measure the degree of real earnings management.⁴ The regression results are presented in Table 12. The results in Column (1) show that corporate green transformation effectively suppresses real earnings management. As shown in Columns (2)–(4), the two opposite indicators, DCFO and DDISEXP, are significantly positively correlated with GT at the 5 % level, and DPROD is significantly negatively correlated with GT at the 1 % level. This result is consistent with the results of the comprehensive index, indicating that green transformation of enterprises can inhibit real earnings management.

6. Discussion

Referring to previous research on the economic consequences of corporate green transformation and factors influencing accrual-based earnings management, this study finds that green transformation can effectively inhibit accrual-based earnings management.

Judging from the research results, this study's mechanism analysis supports Yu's [10] conclusion that analysts' supervisory effect can effectively inhibit corporate accrual earnings management. In the analysis of the mechanism of eliminating the implementation motivation of accrual earnings management, this study supports the following conclusion: the elimination of the financing motivation

⁴ $REM = DPROD - DCFO - DDISEXP$ The larger the DPROD, the more the production cost of the enterprise exceeds the reasonable level, so the abnormal cost is a positive indicator of real earnings management. Abnormal cash flow (DCFO) refers to the difference between a company's actual cash flow and its reasonable cash flow. When the difference is negative and the larger the value, the greater the degree of real earnings management, so abnormal cash flow is a negative aspect of real earnings management. index. Abnormal expenses (DDISEXP) refer to discretionary disposal expenses minus normal expenses. When it is a negative number and the larger the value, the greater the degree of real earnings management, so abnormal expenses are also a negative indicator of real earnings management.

Table 12
Enterprise green transformation and real earnings management.

	(1)	(2)	(3)	(4)
	REM	DPROD	DDISEXP	DCFO
GT	-0.012*** (-3.30)	-0.006*** (-2.80)	0.004** (2.45)	0.003** (2.48)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	14,497	14,497	14,497	14,497
Adj. R2	0.16	0.13	0.09	0.10

Note: output t-value or z-value in brackets, and the standard error is adjusted by company-level clustering.

***p < 0.01, **p < 0.05, *p < 0.1.

can effectively alleviate enterprises' accrual earnings management [31–34]. Of course, this study seems to reach a different conclusion than Giuli et al. [13], who argue that green transformation will increase a company's SG&A, thereby indirectly reducing stock returns. Theoretically, a reduction in stock returns may lead to management's earnings manipulation out of self-interest, which is inconsistent with the conclusions of this study. One possible reason is that green transition increases a company's SG&A. However, with the strong policy support of the Chinese government, the additional benefits brought about by green transformation to enterprises (such as environmental performance and relief of financing constraints) exceed the costs incurred by enterprises, which also inhibits management's motivation to manipulate earnings for self-interest.

From the perspective of research methods, some previous studies on green transitions did not conduct causal analyses [60]. Other studies often use the average number of green patent applications in the same industry as an instrumental variable [77,84] or the system GMM method [16] to alleviate the endogeneity problem. However, this approach has certain drawbacks. First, using the group mean as an instrumental variable usually does not satisfy the requirement of exogeneity. Adding industry fixed effects to the model cannot solve this problem, leading to inconsistent IV estimates [85]. Second, in the dynamic panel, the system GMM can only alleviate the endogeneity of the explained variables and the lagged explained variables but cannot solve the endogeneity of the core explanatory variables and the explained variables. Therefore, this study uses the environmental protection "fee reform tax" policy launched by the Chinese government in 2018 as an exogenous impact, and constructs a PSM-DID model, which can effectively alleviate the possible endogenous problems in this paper. This finding provides a new idea for alleviating the endogeneity problem in subsequent research on the green transformation of Chinese enterprises.

7. Conclusion

Earnings management has always been a key issue in corporate governance and improving accounting information quality is an emerging market goal. As one of the most important forms of sustainable economic development in China, corporate green transformation has a governance effect on earnings management, and is worthy of study. This study selects A-share listed companies in China's Shanghai and Shenzhen stock markets from 2015 to 2021 as the research sample and empirically tests the impact of corporate green transformation on accrual earnings management. The results were as follows:

First, there is a negative correlation between corporate green transformation and accrual-based earnings management, indicating that corporate green transformation effectively inhibits accrual-based earnings management. Simultaneously, corporate green transformation has a strong inhibitory effect on accrual-earnings management, which increases profits. After using the environmental protection "fee reform tax" policy issued by the Chinese government in 2018 to employ a PSM-DID analysis to alleviate endogeneity, the conclusion still holds after a series of robustness tests such as replacing explanatory variables and explained variables.

Second, green transformation and accrual-based earnings management have heterogeneous effects on different enterprise types and lifecycles. Compared with non-high-tech enterprises, the inhibitory effect of corporate green transformation on accrual-based earnings management is greater in high-tech enterprises. Compared with mature and declining companies, the inhibitory effect of corporate green transformation on accrual-based earnings management is greater in growing companies. Compared with companies in a recession, the inhibitory effect of corporate green transformation on accrual-based earnings management is greater in mature companies.

Third, corporate green transformation can inhibit accrual earnings management by limiting its implementation space of earnings management and eliminating the motivation to implement earnings management. Specifically, corporate green transformation can limit the implementation space of earnings management by increasing analyst tracking. It can simultaneously eliminate the motivation for earnings management by easing financing constraints, thereby suppressing accrual earnings management in all aspects.

Finally, the green transformation of enterprises can also effectively inhibit real earnings management; that is, the governance effect of green transformation not only inhibits corporate accrual earnings management but also prevents managers from transforming accrual earnings management into real earnings management.

Policy suggestion

The findings have implications for governments, enterprises, and investors.

- (1) Government perspective. First, as policymakers, the governments of China and other emerging market countries should pay attention to the fact that in addition to protecting the environment, the promulgation of green policies (such as environmental protection “fee to tax,” green credit guidelines, etc.) can also effectively guide enterprises to carry out green transformation, reduce corporate accrual earnings management, and improve the overall accounting information quality of the market. Therefore, the government should continue to adhere to green and sustainable development and introduce green policies.

Second, the government should note that green transformation primarily reduces corporate accrual-based earnings management by increasing analysts’ tracking and easing financing constraints. Therefore, the government should focus on formulating green policies. On the one hand, policies that strengthen green laws and regulations (such as environmental protection “fee to tax”) can guide enterprises to undergo green transformation through a more complete legal system. At the same time, the stricter law enforcement supervision brought about by the policy will also allow companies to gain a better reputation while transforming into green, attract more analysts’ attention, and thus better reduce accrual earnings management. On the other hand, green financial policies (e.g., green credit guidelines) can provide timely financial assistance to enterprises during their green transformation period, thereby improving their financing constraints and reducing accrued earnings management. In general, when formulating green policies, the government can make greater use of these two types of green policies to improve the overall accounting information quality of the market.

Finally, owing to the heterogeneity in firms’ accrual earnings management due to green transformation, the green transformation of high-tech and start-up enterprises can reduce their accrual earnings management levels. Therefore, when formulating green policies, the government should focus on high-tech enterprises and start-up enterprises, and can launch more green policies for these two types of enterprises to maximize the quality of accounting information for these two types of enterprises.

- (2) Enterprise perspective. First, as the main body of green transformation, enterprises must bear the additional costs incurred by green transformation. Some companies may refuse to bear the high costs of a green transformation. However, the research in this article found that green transformation has a “spillover” governance effect on enterprises and can improve the quality of enterprise accounting information. To a certain extent, this effect alleviates enterprises’ concerns regarding the high cost of transformation. Enterprises should be fully aware of the benefits of green transformation brings to the enterprise and actively engage in green transformations.

Second, companies should accelerate their green transformation and establish a corporate green brand value, thereby attracting more analyst attention and reducing accrued earnings management by gaining a good external reputation. Simultaneously, companies should pay more attention to and use green policies (subsidies, tax reduction policies, etc.), make full use of policy dividends to ease financing constraints, and reduce accrued earnings management.

Finally, high-tech enterprises in the start-up stage must actively accelerate the process of green transformation to improve the quality of their accounting information.

- (3) Investors perspective. This study provides a new approach for investors to screen corporate accounting information quality. When evaluating the quality of a company’s accounting information, investors can refer to green information disclosures and vocabulary related to green transformation in the annual report of the company (especially high-tech companies or companies in the startup stage) under the original evaluation standards to more accurately evaluate the quality of corporate accounting information.

Research limitations and future directions

This study had certain limitations. First, the sample includes only China’s A-share listed companies. Although China is the largest emerging market, its data coverage is limited. Therefore, future studies should select larger samples of emerging markets to obtain more robust results. Second, the heterogeneity analysis in this study only examines whether the influence of heterogeneity on high-tech enterprises and the enterprise life cycle is not sufficiently comprehensive. Therefore, future researchers should start with other heterogeneous influencing factors and conduct a more detailed discussion on green transformation and accrual-based earnings management to obtain more robust results. Finally, this study empirically tested the relationship between green transformation and real earnings management. Further theoretical analysis and empirical tests on the mechanism by which green transformation affects real earnings management are needed. Therefore, future research should focus on the impact mechanism of green transformation on real earnings management, and clarify the governance effect of green transformation on accounting information quality more comprehensively.

Data availability statement

Data will be made available on request.

CRedit authorship contribution statement

Yufei Lei: Writing – review & editing, Formal analysis. **Yucong Yan:** Writing – review & editing, Writing – original draft, Visualization, Validation, Data curation. **Chen Chen:** Writing – review & editing, Writing – original draft, Formal analysis. **Tianyao Luo:** Writing – review & editing, Data curation. **Yingdong Wang:** Writing – review & editing, Supervision, Formal analysis. **Hao Wu:** Writing – review & editing, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

Research on the Impact of Population Aging on Digital Transformation of Enterprises: Theoretical Analysis and Empirical Testing (GD23XGL028).

Appendix A. Keywords for corporate green transformation

Green Development; Circular Development; Low-carbon Development; Sustainable Development; Green Building; Recycling; Low-carbon Building; Sustainable Growth; Low-pollution Development; Reducing Energy Consumption; Improving Resource Utilization; Improving Recycling Levels; Low-carbon Life; Green Life; Green Production; Green Consumption; Green Finance; Green Governance; Green Construction; Energy Conservation; Resource Conservation; New Energy Development; Ecological Restoration; Recycling; Energy Conservation and Emission Reduction; Conservation Priority; Protection Priority; Natural Restoration; Improvement of Utilization Rate; Resource Constraints; Environmental Pollution; Ecological Damage; Resource Consumption; Ecosystem Degradation; Resource Depletion; Ecological Environment Damage; Environmental Risk; Environmental Pressure; Biodiversity; Ecosystem; Ecological Function; Ecological Service; Ecological Security; Ecological Protection; Ecological Restoration; Natural Ecology; Species Protection; Caring for the Environment; Caring for the Ecology; Environmental Protection Awareness; Ecological Protection Awareness; Ecological Protection Concept; Ecological Protection Obligation; Ecological Environment Governance Obligation; Ecological Commitment; Environmental Commitment; Environmental Protection Obligation; Environmental Governance Concepts; Environmental Governance Methods; Comprehensive Environmental Governance; Environmental Governance; Environmental Justice; Social Governance; Universal Governance; Source Prevention and Control; Environmental Governance Models; Environmental Protection Governance; Ecological Governance; Ecological Improvement; Ecological Prevention; Pollution Governance; Pollution Prevention and Control; Concept of Ecological Civilization; System of Ecological Civilization; Mechanism of Ecological Security; Ecological Risk Prevention and Control System; Environmental Governance System; Environmental Protection System; Green Technology Innovation System; Ecological Compensation Mechanism; Green Innovation; Green Technology; Green Upgrade; Environmental Protection Upgrade; Environmental Protection Transformation; Low Pollution Transformation; Ecological Red Line; Green Bottom Line; Respect for Nature; Conform to Nature; Protect Nature; Beautiful Towns; Beautiful Villages; Beautiful China; Blue Sky Defense Battle; Clear Water Defense Battle; Environmental Protection Technology; Governance Technology; Governance Level; Environmental Protection Strength; Ecological Protection Technology; Enterprise Pollution Prevention and Control; Enterprise Ecological Protection; Enterprise Environmental Protection Responsibility; Corporate Environmental Protection Responsibility; Corporate Ecological Governance; Corporate Environmental Governance; Corporate Green Upgrade; Corporate Equipment Upgrade; Green Development Strategy; Green Upgrade Strategy; Green Technology Strategy; Green Innovation Strategy.

Appendix B. Univariate mean test results

In this paper, according to the median, the enterprise green transformation data is divided into high-green-transformation and low-green-transformation groups, and the univariate mean test is carried out. The results are shown in [Table A1](#): the |DA| mean value of the high-green-transformation group is 0.043, the |DA| mean value of the low-green-transformation group is 0.055, and the difference between the two is significant at the 1 % level. The results show that regardless of the influence of other factors, the degree of earnings management of the high-green-transformation samples is lower. The average ROA of the high-green-transformation group is 0.031, and the average ROA of the low-green-transformation group is 0.023, and the difference between the two is significant at the level of 1 %. The average Growth of the high-green-transformation group is 0.155, and the average value of the low-green-transformation group is 0.163, and the difference between the two is not significant. It shows that high-green-transformation enterprises have strong profitability, and there is no significant difference between the companies' growth and low-green-transformation samples. This shows to a certain extent that the indicators used can accurately measure the green transformation of enterprises, rather than measuring the "greenwashing" of enterprises (Enterprises with low profitability and poor growth are more motivated to carry out "greenwashing" activities, but the samples with high-green-transformation in this paper have strong profitability, and there is no significant difference between the growth and low green transformation samples, so it proves that the Metrics are scientific and reasonable).

Table A.1
Univariate mean test results

VarName	Obs(0)	Mean(0)	Obs(1)	Mean(1)	Mean-Diff	T
DA	7678	0.055	7354	0.043	0.013***	11.843
Size	7678	7.544	7354	8.002	-0.458***	-23.995
Lev	7678	0.417	7354	0.452	-0.035***	-10.658
ROA	7678	0.023	7354	0.031	-0.008***	-6.444
Top1	7678	31.564	7354	32.778	-1.214***	-5.201
MB	7678	2.412	7354	1.896	0.516***	21.685
Growth	7678	0.163	7354	0.155	0.008	1.235
Age	7678	2.961	7354	3.023	-0.063***	-14.131
Bsize	7678	2.237	7354	2.289	-0.052***	-10.809
Ind	7678	39.601	7354	38.982	0.619***	5.344
Wedge	7678	0.239	7354	0.225	0.014***	7.045
Duality	7678	0.288	7354	0.228	0.060***	8.429

References

- [1] S. Solaymani, CO2 emissions patterns in 7 top carbon emitter economies: the case of transport sector, *Energy* 168 (2019) 989–1001, <https://doi.org/10.1016/j.energy.2018.11.145>.
- [2] N. Houssam, D.M. Ibrahim, S. Sucharita, K.M. El-Aasar, R.R. Esily, N. Sethi, Assessing the role of green economy on sustainable development in developing countries, *Heliyon* (2023), <https://doi.org/10.1016/j.heliyon.2023.e17306>.
- [3] G. Jin, K. Chen, P. Wang, B. Guo, Y. Dong, J. Yang, Trade-offs in land-use competition and sustainable land development in the North China Plain, *Technol. Forecast. Soc.* 141 (2019) 36–46, <https://doi.org/10.1016/j.techfore.2019.01.004>.
- [4] S. Gu, M. Xie, X. Zhang, *Green Transformation and Development*, Palgrave Macmillan, 2019.
- [5] B. Adams, *Green Development: Environment and Sustainability in a Developing World*, Routledge, 2008, <https://doi.org/10.4324/9780203929711>.
- [6] J. Li, Z. Sun, Application of deep learning in recognition of accrued earnings management, *Heliyon* 9 (3) (2023), <https://doi.org/10.1016/j.heliyon.2023.e13664>.
- [7] M.C. Jensen, W.H. Meckling, Theory of the firm: managerial behavior, agency costs and ownership structure, in: *Corporate Governance*, 2019, pp. 77–132, <https://doi.org/10.1002/9780470752135>. Gower.
- [8] K. Schipper, *Earnings management*, *Account. Horiz.* 3 (4) (1989) 91.
- [9] P.M. Healy, K.G. Palepu, Information asymmetry, corporate disclosure, and the capital markets: a review of the empirical disclosure literature, *J. Account. Econ.* 31 (1–3) (2001) 405–440, [https://doi.org/10.1016/S0165-4101\(01\)00018-0](https://doi.org/10.1016/S0165-4101(01)00018-0).
- [10] F.F. Yu, Analyst coverage and earnings management, *J. Financ. Econ.* 88 (2) (2008) 245–271, <https://doi.org/10.1016/j.jfineco.2007.05.008>.
- [11] M.D. Amore, M. Bennesden, B. Larsen, P. Rosenbaum, CEO education and corporate environmental footprint, *J. Environ. Econ. Manag.* 94 (2019) 254–273, <https://doi.org/10.1016/j.jeem.2019.02.001>.
- [12] I. Oikonomou, C. Brooks, S. Pavelin, The effects of corporate social performance on the cost of corporate debt and credit ratings, *Financ. Rev.* 49 (1) (2014) 49–75, <https://doi.org/10.1111/fire.12025>.
- [13] A. Di Giuli, L. Kostovetsky, Are red or blue companies more likely to go green? Politics and corporate social responsibility, *J. Financ. Econ.* 111 (1) (2014) 158–180, <https://doi.org/10.1016/j.jfineco.2013.10.002>.
- [14] Y. Chen, C.C. Lee, Does technological innovation reduce CO2 emissions? Cross-country evidence, *J. Clean. Prod.* 263 (2020), 121550, <https://doi.org/10.1016/j.jclepro.2020.121550>.
- [15] X. Ouyang, W. Zhuang, C. Sun, Haze, health, and income: an integrated model for willingness to pay for haze mitigation in Shanghai, China, *Energy Econ.* 84 (2019), 104535, <https://doi.org/10.1016/j.eneco.2019.104535>.
- [16] C. Lv, C. Shao, C.C. Lee, Green technology innovation and financial development: do environmental regulation and innovation output matter? *Energy Econ.* 98 (2021), 105237 <https://doi.org/10.1016/j.eneco.2021.105237>.
- [17] M.P. Sharfman, C.S. Fernando, Environmental risk management and the cost of capital, *Strat. Manag. J.* 29 (6) (2008) 569–592, <https://doi.org/10.1002/smj.678>.
- [18] S. Fatica, R. Panzica, M. Rancan, The pricing of green bonds: are financial institutions special? *J. Financ. Stabil.* 54 (2021), 100873 <https://doi.org/10.1016/j.jfs.2021.100873>.
- [19] X. Xu, J. Li, Asymmetric impacts of the policy and development of green credit on the debt financing cost and maturity of different types of enterprises in China, *J. Clean. Prod.* 264 (2020), 121574, <https://doi.org/10.1016/j.jclepro.2020.121574>.
- [20] P.T. Chan, T. Walter, Investment performance of “environmentally-friendly” firms and their initial public offers and seasoned equity offers, *J. Bank. Finance* 44 (2014) 177–188, <https://doi.org/10.1016/j.jbankfin.2014.04.006>.
- [21] S. Leung, B. Srinidhi, The effect of the private securities litigation reform act on analyst forecast properties: the impact of firm size and growth opportunities, *J. Bus. Finance Account.* 33 (5–6) (2006) 767–792, <https://doi.org/10.1111/j.1468-5957.2006.00020.x>.
- [22] P.M. Clarkson, X. Fang, Y. Li, G. Richardson, The relevance of environmental disclosures: are such disclosures incrementally informative? *J. Account. Publ. Pol.* 32 (5) (2013) 410–431, <https://doi.org/10.1016/j.jaccpubpol.2013.06.008>.
- [23] Y. Chang, X. Du, Q. Zeng, Does environmental information disclosure mitigate corporate risk? Evidence from China, *J. Contemp. Account. Econ.* 17 (1) (2021), 100239, <https://doi.org/10.1016/j.jcae.2020.100239>.
- [24] P.B. Shane, B.H. Spicer, Market response to environmental information produced outside the firm, *Account. Rev.* (1983) 521–538.
- [25] D. Cormier, M. Magnan, B. Morard, The impact of corporate pollution on market valuation: some empirical evidence, *Ecol. Econ.* 8 (2) (1993) 135–155, [https://doi.org/10.1016/0921-8009\(93\)90041-4](https://doi.org/10.1016/0921-8009(93)90041-4).
- [26] D. Cormier, M. Magnan, Investors’ assessment of implicit environmental liabilities: an empirical investigation, *J. Account. Publ. Pol.* 16 (2) (1997) 215–241, [https://doi.org/10.1016/S0278-4254\(97\)00002-1](https://doi.org/10.1016/S0278-4254(97)00002-1).
- [27] M. Plumlee, D. Brown, R.M. Hayes, R.S. Marshall, Voluntary environmental disclosure quality and firm value: further evidence, *J. Account. Publ. Pol.* 34 (4) (2015) 336–361, <https://doi.org/10.1016/j.jaccpubpol.2015.04.004>.
- [28] P.L. Yadav, S.H. Han, J.J. Rho, Impact of environmental performance on firm value for sustainable investment: evidence from large US firms, *Bus. Strat. Environ.* 25 (6) (2016) 402–420, <https://doi.org/10.1002/bse.1883>.
- [29] J.P. Fan, T.J. Wong, Corporate ownership structure and the informativeness of accounting earnings in East Asia, *J. Account. Econ.* 33 (3) (2002) 401–425, [https://doi.org/10.1016/S0165-4101\(02\)00047-2](https://doi.org/10.1016/S0165-4101(02)00047-2).

- [30] A.A. Aljughaiman, T.H. Nguyen, V.Q. Trinh, A. Du, The Covid-19 outbreak, corporate financial distress and earnings management, *Int. Rev. Financ. Anal.* 88 (2023), 102675, <https://doi.org/10.1016/j.irfa.2023.102675>.
- [31] S.H. Teoh, I. Welch, T.J. Wong, Earnings management and the underperformance of seasoned equity offerings, *J. Financ. Econ.* 50 (1) (1998) 63–99, [https://doi.org/10.1016/S0304-405X\(98\)00032-4](https://doi.org/10.1016/S0304-405X(98)00032-4).
- [32] S.H. Teoh, I. Welch, T.J. Wong, Earnings management and the long-run market performance of initial public offerings, *J. Finance* 53 (6) (1998) 1935–1974, <https://doi.org/10.1111/0022-1082.00079>.
- [33] D.A. Cohen, A. Dey, T.Z. Lys, Real and accrual-based earnings management in the pre-and post-Sarbanes-Oxley periods, *Account. Rev.* 83 (3) (2008) 757–787, <https://doi.org/10.2308/accr.2008.83.3.757>.
- [34] D. Cormier, P. Lapointe-Antunes, B.J. McConomy, Forecasts in IPO prospectuses: the effect of corporate governance on earnings management, *J. Bus. Finance Account.* 41 (1–2) (2014) 100–127, <https://doi.org/10.1111/jbfa.12060>.
- [35] H. Ashbaugh-Skaife, D.W. Collins, W.R. Kinney Jr., R. LaFond, The effect of SOX internal control deficiencies and their remediation on accrual quality, *Account. Rev.* 83 (1) (2008) 217–250, <https://doi.org/10.2308/accr.2008.83.1.217>.
- [36] M. El Diri, C. Lambrinoudakis, M. Alhadab, Corporate governance and earnings management in concentrated markets, *J. Bus. Res.* 108 (2020) 291–306, <https://doi.org/10.1016/j.jbusres.2019.11.013>.
- [37] Y. Qian, A theory of shortage in socialist economies based on the “soft budget constraint”, *Am. Econ. Rev.* 145–156 (1994).
- [38] R. Chung, M. Firth, J.B. Kim, Institutional monitoring and opportunistic earnings management, *J. Corp. Finance* 8 (1) (2002) 29–48, [https://doi.org/10.1016/S0929-1199\(01\)00039-6](https://doi.org/10.1016/S0929-1199(01)00039-6).
- [39] P.S. Koh, On the association between institutional ownership and aggressive corporate earnings management in Australia, *Br. Account. Rev.* 35 (2) (2003) 105–128, [https://doi.org/10.1016/S0890-8389\(03\)00014-3](https://doi.org/10.1016/S0890-8389(03)00014-3).
- [40] J.M.D.L.F. Sabate, E.D.Q. Puente, Empirical analysis of the relationship between corporate reputation and financial performance: a survey of the literature, *Corp. Reput. Rev.* 6 (2003) 161–177, <https://doi.org/10.1057/palgrave.crr.1540197>.
- [41] M. DeFond, J. Zhang, A review of archival auditing research, *J. Account. Econ.* 58 (2–3) (2014) 275–326, <https://doi.org/10.1016/j.jacceco.2014.09.002>.
- [42] N.P.D.R.H. Narsa, L.M.E. Afifa, O.A. Wardhaningrum, Fraud triangle and earnings management based on the modified M-score: a study on manufacturing company in Indonesia, *Heliyon* 9 (2) (2023), <https://doi.org/10.1016/j.heliyon.2023.e13649>.
- [43] S. Kedia, S. Rajgopal, Do the SEC’s enforcement preferences affect corporate misconduct? *J. Account. Econ.* 51 (3) (2011) 259–278, <https://doi.org/10.1016/j.jacceco.2011.01.004>.
- [44] D. Jiang, W. Li, Y. Shen, S. Yu, Does air pollution affect earnings management? Evidence from China, *Pac. Basin Finance J.* 72 (2022), 101737, <https://doi.org/10.1016/j.pacfin.2022.101737>.
- [45] Y. Wang, L. Guo, J. Tu, Y. Huang, B. Ye, How environmental protection tax affect corporate earnings management—evidence from Chinese manufacturing industry enterprises. Highlights, *Bus. Econ. Manag.* 16 (2023) 34–43, <https://doi.org/10.54097/hbem.v16i1.10531>.
- [46] A.M. Gerged, K. Albitar, L. Al-Haddad, Corporate environmental disclosure and earnings management—the moderating role of corporate governance structures, *Int. J. Financ. Econ.* 28 (3) (2023) 2789–2810, <https://doi.org/10.1002/ijfe.2564>.
- [47] Y. Shang, Y. Chi, Corporate environmental information disclosure and earnings management in China: ethical behaviour or opportunism motivation? *Sustainability* 15 (11) (2023) 8896, <https://doi.org/10.3390/su15118896>.
- [48] B. Litt, D. Sharma, V. Sharma, Environmental initiatives and earnings management, *Manag. Audit J.* 29 (1) (2013) 76–106, <https://doi.org/10.1108/MAJ-05-2013-0867>.
- [49] P. Zhang, J. Wei, J. Jiang, ESG information disclosure and corporate earnings management—research on the moderating effect based on media attention, *J. Educ. Humanit. Soc. Sci.* 16 (2023) 69–79, <https://doi.org/10.54097/ehss.v16i.9499>.
- [50] M.C. Kolsi, A. Al-Hiyari, K. Hussainey, Does environmental, social, and governance performance mitigate earnings management practices? Evidence from US commercial banks, *Environ. Sci. Pollut. Res.* 30 (8) (2023) 20386–20401, <https://doi.org/10.1007/s11356-022-23616-2>.
- [51] R.K. Brahmana, M.Y. Tan, H.W. You, Corporate environmental disclosure and earning management, *Int. J. Green Econ.* 12 (3–4) (2018) 308–321, <https://doi.org/10.1504/IJGE.2018.097874>.
- [52] W. Long, X. Qu, S. Yin, How does carbon emissions trading policy affect accrued earnings management in corporations? Evidence from China, *Finance Res. Lett.* (2023), 103840, <https://doi.org/10.1016/j.frl.2023.103840>.
- [53] A. George, *The Market for Lemons: Quality Uncertainty and the Market Mechanism*, 1970.
- [54] T.D. Warfield, J.J. Wild, K.L. Wild, Managerial ownership, accounting choices, and informativeness of earnings, *J. Account. Econ.* 20 (1) (1995) 61–91, [https://doi.org/10.1016/0165-4101\(94\)00393-J](https://doi.org/10.1016/0165-4101(94)00393-J).
- [55] V.J. Richardson, Information asymmetry and earnings management: some evidence, *Rev. Quant. Finance Account.* 15 (2000) 325–347, <https://doi.org/10.1023/A:1012098407706>.
- [56] S.A. Ross, *The economic theory of agency: the principal’s problem*, *Am. Econ. Rev.* 63 (2) (1973) 134–139.
- [57] X. Chen, Q. Cheng, A.K. Lo, X. Wang, CEO contractual protection and managerial short-termism, *Account. Rev.* 90 (5) (2015) 1871–1906, <https://doi.org/10.2308/accr-51033>.
- [58] R.M. Bushman, J.D. Piotroski, A.J. Smith, Insider trading restrictions and analysts’ incentives to follow firms, *J. Finance* 60 (1) (2005) 35–66, <https://doi.org/10.1111/j.1540-6261.2005.00724.x>.
- [59] M.V. Russo, The emergence of sustainable industries: Building on natural capital, *Strat. Manag. J.* 24 (4) (2003) 317–331, <https://doi.org/10.1002/smj.298>.
- [60] R.R. Ahmed, W. Akbar, M. Aijaz, Z.A. Channar, F. Ahmed, V. Parmar, The role of green innovation on environmental and organizational performance: moderation of human resource practices and management commitment, *Heliyon* 9 (1) (2023), <https://doi.org/10.1016/j.heliyon.2022.e12679>.
- [61] M.V. Russo, P.A. Fouts, A resource-based perspective on corporate environmental performance and profitability, *Acad. Manag. J.* 40 (3) (1997) 534–559, <https://doi.org/10.5465/257052>.
- [62] J. Cui, H. Jo, H. Na, Does corporate social responsibility affect information asymmetry? *J. Bus. Ethics* 148 (2018) 549–572, <https://doi.org/10.1007/s10551-015-3003-8>.
- [63] J.D. Piotroski, D.T. Roulstone, The influence of analysts, institutional investors, and insiders on the incorporation of market, industry, and firm-specific information into stock prices, *Account. Rev.* 79 (4) (2004) 1119–1151, <https://doi.org/10.2308/accr.2004.79.4.1119>.
- [64] D.S. Dhaliwal, O.Z. Li, A. Tsang, Y.G. Yang, Voluntary nonfinancial disclosure and the cost of equity capital: the initiation of corporate social responsibility reporting, *Account. Rev.* 86 (1) (2011) 59–100, <https://doi.org/10.2308/accr.00000005>.
- [65] C. Serrano-Cinca, B. Gutiérrez-Nieto, N.M. Reyes, A social and environmental approach to microfinance credit scoring, *J. Clean. Prod.* 112 (2016) 3504–3513, <https://doi.org/10.1016/j.jclepro.2015.09.103>.
- [66] H. Wang, H. Cui, Q. Zhao, Effect of green technology innovation on green total factor productivity in China: evidence from spatial Durbin model analysis, *J. Clean. Prod.* 288 (2021), 125624, <https://doi.org/10.1016/j.jclepro.2020.125624>.
- [67] Z. Min, Chain shareholders and green transformation of enterprises, *Acad. J. Bus. Manag.* 5 (6) (2023) 127–135, <https://doi.org/10.25236/AJBM.2023.050619>.
- [68] L.T. Hosmer, The institutionalization of unethical behavior, *J. Bus. Ethics* 6 (1987) 439–447, <https://doi.org/10.1007/BF00383286>.
- [69] P.M. Dechow, R.G. Sloan, A.P. Sweeney, Detecting Earnings Management, *Account. Rev.* 193–225, 1995. <https://www.jstor.org/stable/248303>.
- [70] T. Loughran, B. McDonald, When is a liability not a liability? Textual analysis, dictionaries, and 10-Ks, *J. Finance* 66 (1) (2011) 35–65, <https://doi.org/10.1111/j.1540-6261.2010.01625.x>.
- [71] R.M. Frankel, M.F. Johnson, K.K. Nelson, The relation between auditors’ fees for nonaudit services and earnings management, *Account. Rev.* 77 (s-1) (2002) 71–105, <https://doi.org/10.2308/accr.2002.77.s-1.71>.
- [72] D. Acemoglu, P. Aghion, L. Bursztyn, D. Hemous, The environment and directed technical change, *Am. Econ. Rev.* 102 (1) (2012) 131–166, <https://doi.org/10.1257/aer.102.1.131>.

- [73] S. Abdullah, B. Morley, Environmental taxes and economic growth: evidence from panel causality tests, *Energy Econ.* 42 (2014) 27–33, <https://doi.org/10.1016/j.eneco.2013.11.013>.
- [74] V. Dickinson, Cash flow patterns as a proxy for firm life cycle, *Account. Rev.* 86 (6) (2011) 1969–1994, <https://doi.org/10.2308/accr-10130>.
- [75] J.J. Jones, Earnings management during import relief investigations, *J. Account. Res.* 29 (2) (1991) 193–228, <https://doi.org/10.2307/2491047>.
- [76] S.P. Kothari, A.J. Leone, C.E. Wasley, Performance matched discretionary accrual measures, *J. Account. Econ.* 39 (1) (2005) 163–197, <https://doi.org/10.1016/j.jacceco.2004.11.002>.
- [77] J. Wu, Q. Xia, Z. Li, Green innovation and enterprise green total factor productivity at a micro level: a perspective of technical distance, *J. Clean. Prod.* 344 (2022), 131070, <https://doi.org/10.1016/j.jclepro.2022.131070>.
- [78] Y. Zhong, H. Zhao, T. Yin, Resource bundling: how does enterprise digital transformation affect enterprise ESG development? *Sustainability* 15 (2) (2023) 1319, <https://doi.org/10.3390/su15021319>.
- [79] O. Dessaint, A. Golubov, P. Volpin, Employment protection and takeovers, *J. Financ. Econ.* 125 (2) (2017) 369–388, <https://doi.org/10.1016/j.jfineco.2017.05.005>.
- [80] T.M. Whited, G. Wu, Financial constraints risk, *Rev. Financ. Stud.* 19 (2) (2006) 531–559, <https://doi.org/10.1093/rfs/hhj012>.
- [81] J.J. He, X. Tian, The dark side of analyst coverage: the case of innovation, *J. Financ. Econ.* 109 (3) (2013) 856–878, <https://doi.org/10.1016/j.jfineco.2013.04.001>.
- [82] R.M. Irani, D. Oesch, Analyst coverage and real earnings management: quasi-experimental evidence, *J. Financ. Quant. Anal.* 51 (2) (2016) 589–627, <https://doi.org/10.1017/S0022109016000156>.
- [83] S. Roychowdhury, Earnings management through real activities manipulation, *J. Account. Econ.* 42 (3) (2006) 335–370, <https://doi.org/10.1016/j.jacceco.2006.01.002>.
- [84] S. El Ghoul, O. Guedhami, C.C. Kwok, D.R. Mishra, Does corporate social responsibility affect the cost of capital? *J. Bank. Finance* 35 (9) (2011) 2388–2406, <https://doi.org/10.1016/j.jbankfin.2011.02.007>.
- [85] T.A. Gormley, D.A. Matsa, Common errors: how to (and not to) control for unobserved heterogeneity, *Rev. Financ. Stud.* 27 (2) (2014) 617–661, <https://doi.org/10.1093/rfs/hht047>.