Managerial
Finance

Corporate digital transformation and financing cost of green bond: evidence from China

Zhufeng Huang
UTS Business School, University of Technology Sydney, Sydney, Australia

Received 28 January 2026
Revised 17 May 2026
Accepted 8 July 2026

Abstract

Purpose – This study aims to examine whether and how corporate digital transformation (CDT) affects green bond financing costs. Drawing on signaling and agency theories, it argues that CDT lowers credit spreads by improving environmental information credibility and internal control quality.

Design/methodology/approach – Using firm–bond observations from Chinese A-share listed companies issuing green bonds between 2016 and 2024, this study applied a text-based CDT index from annual reports and measures financing cost using credit spreads over matched risk-free benchmarks. Fixed-effects regressions are supplemented by alternative variable measurements, entropy balancing, instrumental-variable estimation and channel tests.

Findings – CDT is significantly associated with lower green bond credit spreads, and the result remains robust across multiple specifications. Channel analyses show that CDT reduces financing costs partly by improving environmental information disclosure quality and strengthening internal control quality. Sobel and bootstrap tests further support these partial mediation effects.

Originality/value – This study extends CDT research to sustainable finance and identifies digital transformation as a firm-level determinant of green bond pricing. It shows that CDT helps reduce green-specific information and agency frictions related to environmental credibility, use-of-proceeds integrity and greenwashing risk.

Keywords Corporate digital transformation, Green bonds, Financing cost, Sustainable finance

Paper type Research article

1. Introduction

Against the backdrop of global climate governance, achieving the "Dual Carbon" goals and fulfilling the Paris Agreement require firms to undergo a dual transformation—decarbonizing both the "financing end" and the "production end." On the financing side, firms must mobilize low-cost, long-term capital, while on the production side, they need to integrate real-time data and intelligent decision-making to reduce carbon intensity. Green bonds serve as a core instrument of this capital lever, with global issuance reaching USD 671.7 billion in 2024 [1]. By channeling funds into renewable energy, energy efficiency, and pollution control, green bonds help reduce carbon emission intensity (Flammer, 2021), and superior environmental performance further lowers the capital costs of green projects (Ambec and Lanoie, 2008). Meanwhile, corporate digital transformation (CDT) acts as a technological lever that reshapes firms' production functions through Artificial Intelligence (AI), Internet of Things (IoT), and blockchain. Real-time energy monitoring enabled by digitalization reduces the carbon footprint per unit of output (Sun *et al.*, 2025), while blockchain-based ESG (Environmental, Social, and Governance) data infrastructures enhance transparency and mitigate information asymmetry in green projects (Li *et al.*, 2024a). When these capital and technological levers

JEL Classification — G32, O33, Q56

Disclosure: The author reports no conflicts of interest.

Managerial Finance
Emerald Publishing Limited
e-ISSN: 1758-7743
p-ISSN: 0307-4358
DOI 10.1108/MF-12-2025-1015

converge within the same firm, green bond credit spreads should theoretically benefit from a "double discount", reflecting both improved green cash flows and lower agency costs. However, this proposition lacks direct evidence from bond-level microdata, particularly in China. Clarifying how CDT maps onto green bond spreads is therefore crucial for understanding firms' financing costs and the efficient allocation of capital toward emission-reduction projects under the "Dual Carbon" goals.

Existing research presents divergent views on the capital market effects of CDT. The positive strand argues that CDT reduces corporate debt financing costs by enhancing information transparency and earnings persistence (Liu and Dang, 2025). Moderate digital transformation can further lower agency costs and irrational decision-making, thereby improving corporate resilience (Wang *et al.*, 2025), easing financing constraints by mitigating information asymmetry and transaction costs (He *et al.*, 2024), increasing media and academic scrutiny that curbs corporate tax avoidance (Chen *et al.*, 2024), improving information transparency and bond rating quality (Wu *et al.*, 2025), and facilitating more efficient access to green finance, particularly in tourism firms (Ye and Miao, 2025). In contrast, the negative view emphasizes that the technological and human capital adjustments associated with CDT may heighten financial risk, especially in manufacturing firms (Zhou and Zhang, 2025). Deep digitalization may also suppress financial asset holdings and capitalization (Sui and Yao, 2023), crowd out trade credit through asset specificity and bank credit channels (Zhou and Li, 2023), and increase the likelihood of corporate fraud due to weakened internal control and external supervision (Lu *et al.*, 2025). In general, these findings suggest that the financial consequences of CDT are highly context-dependent and mediated by specific transmission mechanisms. Yet, in the green bond market, where environmental and financial attributes intersect, these mechanisms remain largely unexplored.

Drawing on signaling theory and agency theory, this study develops a testable hypothesis linking CDT to green bond financing costs. From a signaling theory perspective, CDT improves firms' ability to collect, process, and disclose environmental and project-level information, thereby enhancing the credibility, traceability, and verifiability of green signals. This reduces information asymmetry between issuers and investors and lowers the required risk premium. From an agency theory perspective, CDT strengthens internal control and monitoring systems, improves the traceability of green bond proceeds, and reduces managerial discretion over fund allocation and environmental reporting. These improvements mitigate agency concerns such as fund diversion and greenwashing. Therefore, CDT is expected to reduce the financing cost of green bonds by alleviating both information asymmetry and agency frictions.

As one of the world's largest green bond markets, China simultaneously pursues the "Dual Carbon" goals and the "Digital China" strategy. This policy-level coupling of green finance and digital transformation underscores China's pivotal role in mobilizing capital for low-carbon transition while generating strong exogenous institutional pressure. Since Shanghai Pudong Development Bank issued China's first labeled green bond in 2016, green bonds have become a core component of the country's green finance system, providing refinancing channels for issuers and new pathways for green development (Dou and Qi, 2019; Yuan *et al.*, 2025). China's green bond issuance has consistently ranked among the world's largest, with labeled issuance in the domestic market increasing by 60% from 2016 to 2019 [2]. Between 2016 and 2024, total issuance expanded from RMB 201.8 billion to RMB 683.3 billion, corresponding to an average annual growth rate of 16.5% [3]. Meanwhile, Chinese regulators have promoted the internationalization of sovereign green bond frameworks, attracting global investors and strengthening cross-border collaboration in green finance. Simultaneously, CDT in China is advancing rapidly. By 2024, core digital economy sectors accounted for 10% of GDP, reflecting the deepening integration of digital and industrial innovation [4]. This unique institutional environment, characterized by clear decarbonization objectives, active green finance experimentation, and heterogeneous digital transformation trajectories, provides a valuable setting for examining how digitalization shapes corporate behavior and capital market outcomes, while offering insights for other emerging economies and contributing to a more inclusive sustainable finance framework.

The empirical results show that CDT significantly reduces the financing cost of green bonds. Based on firm-bond observations of Chinese A-share listed companies from 2016 to 2024, CDT is negatively associated with green bond credit spreads, and this relationship remains significant after controlling for firm-level, bond-level, macroeconomic, and fixed-effect factors. The finding is robust to alternative variable measurements, entropy balancing, and instrumental-variable estimation. Further analyses indicate that CDT lowers green bond spreads through two channels: improving environmental information disclosure quality and strengthening internal control quality. Sobel and bootstrap tests provide additional support for these partial mediation effects.

This study makes three primary contributions. First, it extends the literature on the economic consequences of CDT by examining its role in the green bond market, thereby establishing a novel theoretical link between corporate digital capabilities and sustainable finance. Existing studies mainly focus on CDT's effects on internal operations or traditional capital markets, showing that it promotes technological innovation (Fang and Liu, 2024), improves resource allocation efficiency (Jiang and Li, 2024), enhances labor investment efficiency (Wang *et al.*, 2024), and reshapes workforce structures (Dou *et al.*, 2023). Although recent research has begun to explore CDT's environmental implications, such as its effects on environmental performance (Song *et al.*, 2024) and green innovation (Zheng and Zhang, 2023; Sun *et al.*, 2025), it has not been systematically incorporated into the green finance framework. This study fills this gap by elucidating how CDT affects green bond financing costs.

Second, this research expands the determinants of green bond financing costs by introducing a firm-level strategic factor. Prior studies emphasize macro-level policy influences, including carbon trading pilots (Yuan *et al.*, 2025), collateral-based monetary policies (Xue and Yun, 2024), and the Belt and Road Initiative (Jian *et al.*, 2022), but they offer limited explanations for cross-firm heterogeneity under similar policy environments. While some work considers green certification (Hu *et al.*, 2022) and ownership structure (Sheng *et al.*, 2021), this study captures the marginal effect of firms' dynamic digital transformation.

Third, this study provides important practical implications for policymakers and managers. At the policy level, it supports the development of digital-transformation-oriented green finance frameworks, such as linking firms' digital maturity to green bond certification and evaluation. For firms, it quantifies the financing benefits of digitalization and offers an empirical basis for designing digital investment strategies in environmental monitoring, ESG data governance, and disclosure enhancement.

2. Literature review

2.1 Theoretical background and significance of green bonds

Green bonds have emerged as a central instrument of sustainable finance, designed to mobilize capital for projects with explicit environmental benefits, such as renewable energy, pollution control, climate adaptation, and low-carbon transition (Flammer, 2021). Unlike conventional bonds, green bonds are characterized by a "green promise": issuers commit to allocating proceeds to eligible green projects and disclosing information on the use of proceeds and environmental outcomes (International Capital Market Association, 2021). This feature creates a distinct risk–return structure. While conventional bond investors mainly price default risk, liquidity risk, maturity structure, and issuer credit quality (Jiang *et al.*, 2025), green bond investors must additionally assess the credibility of environmental claims, the integrity of proceeds allocation, and potential greenwashing risk (Hu *et al.*, 2022).

Green bonds also function as a commitment device in the transition toward a low-carbon economy. Under the "green bonding hypothesis," green bond issuance exposes firms to stronger external scrutiny, third-party verification, and specialized disclosure requirements, enabling issuers to signal credible environmental commitments to capital markets (Flammer, 2021). Prior evidence suggests that policy support, green certification, environmental disclosure, and carbon-market mechanisms affect green bond pricing by reducing information asymmetry and strengthening investors' confidence in issuers' environmental credibility (Hu *et al.*, 2022; Li *et al.*, 2020; Yuan *et al.*, 2025). Therefore, the financing cost of green bonds warrants separate analysis from the broader bond market because green bond spreads reflect not only conventional credit risk, but also green-specific pricing frictions related to environmental credibility, use-of-proceeds integrity, post-issuance monitoring, and greenwashing concerns. This distinction makes the green bond market a theoretically meaningful setting for examining the capital-market consequences of CDT, as digital technologies may improve environmental data traceability, disclosure credibility, and internal monitoring over green proceeds.

2.2 Economic consequences of corporate digital transformation

CDT represents a systematic strategic shift whereby firms integrate technologies such as AI, Blockchain, and IoT to reshape their production functions and organizational logic (Jiang *et al.*, 2025). The literature on the economic consequences of CDT has grown rapidly and can be organized into three main streams. First, in terms of operational optimization, CDT enhances resource allocation efficiency and total factor productivity by improving data-processing capabilities (Jiang and Li, 2024; Wang *et al.*, 2024). Recent evidence further shows that digitalization strengthens corporate resilience and eases financing constraints by mitigating information asymmetry (He *et al.*, 2024; Wang *et al.*, 2025). Second, the innovation-oriented literature demonstrates that CDT promotes both digital and green technological innovation by enhancing internal control quality and R&D efficiency (Fang and Liu, 2024; Zheng and Zhang, 2023). Third, the environmental sustainability literature suggests that CDT improves ESG performance by providing more granular and transparent data for sustainability reporting (Liu *et al.*, 2024). The closest study to this paper is Jiang *et al.* (2025), which documents that CDT reduces corporate bond credit spreads in China through lower default risk and reduced information asymmetry. However, green bonds differ from general corporate bonds because their pricing incorporates not only credit risk and information asymmetry but also environmental credibility, proceeds earmarking, and greenwashing risk. This study therefore extends Jiang *et al.* (2025) by examining whether CDT reduces green-specific pricing frictions in the green bond market.

2.3 Influencing factors of the financing cost of green bonds

The financing cost of green bonds, commonly measured by the yield spread over comparable risk-free benchmarks, is shaped by both conventional bond-pricing factors and green-specific attributes (Li *et al.*, 2020). Prior research identifies three broad categories of determinants: bond-level characteristics, green-credibility mechanisms, and issuer or institutional factors. First, bond-level characteristics such as credit ratings, maturity, and liquidity remain fundamental (Hu *et al.*, 2022). Second, the green label and the credibility of third-party certification are pivotal. Green bonds with authoritative verification exhibit lower financing costs by mitigating greenwashing concerns (Hu *et al.*, 2022; Zirek and Unsal, 2023). Higher-quality environmental information disclosure is also associated with reduced spreads (Tang *et al.*, 2023). Third, the issuer's institutional and strategic environment matters significantly. In China, state-owned enterprises often benefit from lower financing costs due to implicit government guarantees (Jian *et al.*, 2022), while firms in high-pollution industries may experience larger spread reductions if their green issuance signals a credible strategic pivot (Wang *et al.*, 2020). Macro-level factors, such as carbon trading pilots and regional digital infrastructure, also play a moderating role (Yuan *et al.*, 2025). Despite this growing literature, little is known about whether firms' internal digital maturity affects green bond pricing. This omission is important because CDT may serve as a technological enabler of both environmental disclosure and governance over green proceeds. This study therefore introduces CDT as a firm-level strategic capability that may reshape green debt pricing in the digital economy era.

3. Hypothesis development

3.1 Information transparency channel: a signaling theory perspective

Signaling theory posits that in environments of information asymmetry, high-quality firms can distinguish themselves from peers by transmitting costly and credible signals to the market (Ross, 1977; Spence, 1973). In the green bond market, investors face not only conventional uncertainty about issuer quality and repayment capacity, but also environmental integrity risk. This risk concerns whether bond proceeds are genuinely allocated to eligible green projects and whether the reported environmental outcomes are credible (Flammer, 2021; Hu *et al.*, 2022). Although issuers may disclose sustainability-related information, such disclosures can be descriptive, backward-looking, and difficult for investors to verify. As a result, investors may discount green claims and require a higher risk premium when the credibility of environmental information is uncertain (Li *et al.*, 2020).

CDT functions as a signal authenticator that enhances the quality of environmental information disclosure. The integration of "ABCD" technologies (AI, Blockchain, Cloud Computing, and Big Data) enables firms to capture project-level environmental metrics, such as real-time carbon emissions and energy efficiency, with unprecedented granularity and frequency (Liu and Dang, 2025). This digital infrastructure constitutes a high signaling cost that is prohibitively expensive for greenwashers to mimic without substantive green operations, thereby making green signals more difficult to imitate or manipulate. By improving the transparency, verifiability, and timeliness of environmental disclosures, CDT reduces the information processing costs for bondholders and alleviates concerns regarding greenwashing. Consequently, investors demand a lower information risk premium, which manifests as a reduction in the credit spread of green bonds (Tang *et al.*, 2023).

3.2 Governance and agency channel: an agency theory perspective

From the perspective of agency theory, the separation of ownership and control creates incentives for self-interested managers to engage in opportunistic behaviors that may erode creditor value (Jensen and Meckling, 1976). In the context of green bonds, this manifests as an eco-agency problem, where managers may divert earmarked green funds toward high-risk general operations or engage in symbolic compliance to secure the greenium without delivering environmental benefits (Peng and Xie, 2024). Because green bonds require strict earmarking of proceeds, they impose higher monitoring costs on creditors than conventional bonds (Dou and Qi, 2019).

CDT can mitigate these agency frictions by strengthening internal control quality and improving the traceability of corporate processes. Digitalized monitoring systems allow firms to generate more traceable records of transactions, fund allocation, project milestones, and environmental performance indicators (Li *et al.*, 2024b). These systems reduce managerial discretion, improve process standardization, and make abnormal fund diversion or symbolic compliance easier to detect (Ajakwe *et al.*, 2025). In this sense, CDT improves the monitoring of green bond proceeds and reduces the likelihood of opportunistic behavior (Huang *et al.*, 2025). By enhancing internal control quality, CDT can also strengthen creditors' confidence that green bond proceeds will be used for their intended purposes and that environmental commitments will be honored. As perceived moral hazard, fund-misuse risk, and greenwashing concerns decline, investors are likely to demand lower governance-related risk compensation (Liu and Dang, 2025). Therefore, CDT may reduce green bond financing costs by alleviating agency frictions associated with the use of green bond proceeds and environmental reporting (Zhao *et al.*, 2023).

While Jiang *et al.* (2025) show that CDT reduces generic bond spreads by lowering default risk and information asymmetry, the green bond setting introduces additional pricing frictions related to environmental disclosure credibility, proceeds earmarking, post-issuance monitoring, and greenwashing risk. Green bonds are therefore more sensitive to non-financial information quality and project-level governance than conventional bonds. By serving as both a signal-enhancing mechanism for environmental disclosure and a governance-enhancing mechanism for internal control, CDT can address the specific informational and agency vulnerabilities embedded in green bond markets. Accordingly, this study proposes the following hypothesis:

H1. Ceteris paribus, a higher degree of corporate digital transformation is associated with lower financing costs for green bonds.

4. Research design

4.1 Sample selection and data sources

The year 2016 is widely recognized as the inaugural year for the development of green finance in China, marked by the issuance of the country's first standardized green bond. Subsequently, a series of supportive policies issued by the People's Bank of China (PBOC), the Ministry of Finance (MoF), and the China Securities Regulatory Commission (CSRC) have facilitated the rapid expansion of China's green bond market. To ensure data availability and consistency, this study focuses on labeled green bonds issued by Chinese A-share listed companies from 2016 to 2024. Observations with missing key variables are excluded and all continuous variables are winsorized at the 1st and 99th percentiles to mitigate the influence of outliers. Data on green bonds and corporate financial information are sourced from the China Stock Market and Accounting Research Database (CSMAR) and the Chinese Research Data Services (CNRDS) platform. The final sample comprises 533 firm-bond observations.

4.2 Variables

In the context of the digital economy, corporate digital transformation represents a critical adaptation to contemporary demands, enabling sustained development and innovation in the evolving business environment. Following the methodology of Wu *et al.* (2021), this study identifies and filters keywords related to the application of key digital technologies—Artificial Intelligence, Blockchain, Cloud Computing, Big Data, and other digital technologies—from corporate annual reports (Table 1). This process forms the ABCD + featured keyword lexicon, covering multiple essential dimensions of corporate digital development. PDF versions of all A-share listed companies' annual reports are collected from the official websites of the Shanghai and Shenzhen Stock Exchanges for the period 2016–2024 using Python. Text is extracted from these PDFs using Java PDFBox, and corporate digital transformation keywords are identified based on the ABCD + lexicon. The explanatory variable, *CDT*, is measured as the natural logarithm of one plus the total frequency of keywords identified from the lexicon.

Following prior studies on green bond financing costs and credit spreads (Li *et al.*, 2020; Hu *et al.*, 2022; Yuan *et al.*, 2025; Zhou and Gao, 2026), this study uses the credit spread of green bonds to measure their financing cost. *Spread* is defined as the difference between the at-issue yield of a corporate green bond and the yield of a Treasury bond with the same issuance year and comparable maturity. Since many fixed-rate green bonds in China are issued at par, the coupon rate is used as a proxy for the at-issue yield when the reported issuance yield is unavailable. Under par issuance, the coupon rate closely approximates the yield to maturity at issuance because no issuance premium or discount exists. A higher *Spread* indicates a higher financing cost for the issuer. When a Treasury bond yield with exactly the same maturity is unavailable, the risk-free benchmark is obtained through interpolation.

Table 1. Corporate digital transformation word mapping

Categories	Vocabularies
Artificial Intelligence	Artificial Intelligence, Business Intelligence, Image Understanding, Investment Decision Assistance System, Intelligent Data Analysis, Intelligent Robotics, Machine Learning, Deep Learning, Semantic Search, Biometrics, Face Recognition, Speech Recognition, Identity Verification, Autonomous Driving
Blockchain	Blockchain, Digital Currency, Distributed Computing, Differential Privacy Technology, Smart Financial Contracts
Cloud computing	Cloud Computing, Stream Computing, Graph Computing, Memory Computing, Multi-party Secure Computing, Brain-like Computing, Green Computing, Cognitive Computing, Fusion Architecture, 100 Million Level Concurrency, EB Level Storage, Internet Of Things, Information Physical System
Big data	Big Data, Data Mining, Text Mining, Data Visualization, Heterogeneous Data, Credit Investigation, Augmented Reality, Mixed Reality, Virtual Reality
Digital technology application	Mobile Internet, Industrial Internet, Mobile Internet, Internet Medical Care, E-commerce, Mobile Payment, Third-party Payment, Near Field Communication Payment, Smart Energy, Business To Business, Business To Customer, Customer To Business, Customer To Consumer, Online To Offline, Network Connection, Smart Wearing, Smart Agriculture, Smart Transportation, Smart Medical Care, Smart Customer Service, Smart Home, Smart Investment, Smart Cultural Tourism, Smart Environmental Protection, Smart Power Grid, Smart Marketing, Digital Marketing, Unmanned Retail, Internet Finance, Digital Finance, Fintech, Fintech, Quantitative Finance, Open Banking

Note(s): This table reports the keyword mapping used to measure corporate digital transformation (CDT). Following prior text-based studies, digital transformation keywords are grouped into five categories: artificial intelligence, blockchain, cloud computing, big data, and digital technology application. The CDT index is constructed from the frequency of these keywords in firms' annual reports

Source(s): Author's own work

The financing cost of green bonds may also be affected by issuer characteristics, bond-specific features, and local macroeconomic conditions. Following prior studies on green bond pricing and corporate bond spreads (Flammer, 2021; Hu *et al.*, 2022; Li *et al.*, 2020; Yuan *et al.*, 2025), this study includes a set of firm-level, bond-level, and macro-level control variables. At the firm level, the controls include leverage ratio (*Leverage*), firm size (*Size*), fixed asset turnover (*Turnover*), return on equity (*ROE*), and state ownership (*SOE*). At the bond level, the controls include redeemability (*Redeemable*), credit rating (*Rating*), issuance amount (*Amount*), and bond maturity (*Maturity*). At the macro level, this study controls for local economic conditions (*GDP*). Table 2 provides detailed definitions for all variables.

5. Empirical results

5.1 Descriptive statistics

Table 2 reports the descriptive statistics for the main variables used in this study. The final sample consists of 533 firm-bond observations. The mean value of *CDT* is 2.269, with a standard deviation of 1.125, indicating substantial cross-sectional variation in firms' digital transformation levels. The median value of *CDT* is 2.639, suggesting that a considerable proportion of green bond issuers have already engaged in digital transformation to varying degrees. The dependent variable, the financing cost of green bonds (*Spread*), has a mean of 0.875% and a median of 0.645%, with a standard deviation of 0.786%. The spread ranges from −0.659% to 4.521%, suggesting that some green bonds are issued at yields below comparable Treasury benchmarks, while others require a substantial positive risk premium.

The firm-level control variables show reasonable distributions. *Leverage* has a mean value of 0.726, indicating that green bond issuers in the sample generally have relatively high

Table 2. Variable definitions and descriptive statistics

Name	Variable definition	Symbols	*N*	Mean	P25	Median	P75	SD	Min	Max
Corporate digital transformation	Natural logarithm of the total word frequency plus one	*CDT*	533	2.269	1.609	2.639	2.996	1.125	0.000	4.736
Credit spread of the green bond	The percentage difference between the coupon rate of green bonds and the yield of Treasury bonds of the same period and maturity	*Spread*	533	0.875	0.405	0.645	1.024	0.786	−0.659	4.521
Leverage ratio	Total debt (including both long-term debt and short-term debt in current liabilities) divided by the book value of total assets	*Leverage*	533	0.726	0.608	0.750	0.818	0.143	0.160	0.943
Firm size	Natural logarithm of bond issuer's total assets	*Size*	533	26.329	25.079	25.997	27.683	1.827	21.441	31.431
Fixed asset turnover ratio	Turnover of fixed assets	*Turnover*	533	2.047	0.313	1.097	2.327	2.819	0.022	21.911
Return on equity	Return on equity	*ROE*	533	0.021	0.012	0.018	0.027	0.016	−0.031	0.130
State ownership	Dummy variable that takes the value of 1 if the bond issuer is a state-owned enterprise, and 0 otherwise	*SOE*	533	0.696	0.000	1.000	1.000	0.460	0.000	1.000
Redeemability of bonds	Dummy variable equal to 1 if the bond is redeemable, and 0 otherwise	*Redeemable*	533	0.099	0.000	0.000	0.000	0.300	0.000	1.000
Bond rating	Bond ratings are mapped numerically: < AA = 1, AA = 2, AA+ = 3, AAA = 4	*Rating*	533	3.486	3.000	4.000	4.000	0.982	1.000	4.000
Bond size	Bond issuance scale in billions of RMB	*Amount*	533	2.385	0.210	0.560	1.788	5.194	0.001	30.000
Bond maturity	Natural logarithm of the number of years until maturity	*Maturity*	533	1.006	0.693	1.099	1.609	1.079	−3.219	3.193
GDP growth	Growth of GDP of the city where the bond issuer is located	*GDP*	533	4.856	3.200	5.300	6.720	2.848	−5.300	11.500

Note(s): *N* denotes the number of firm-bond observations; SD denotes standard deviation; P25, Median and P75 denote the 25th, 50th and 75th percentiles, respectively. All continuous variables are winsorized at the 1st and 99th percentiles

Source(s): Author's own work

leverage. *Size*, measured as the natural logarithm of the bond issuer's total assets, has a mean of 26.329, reflecting the large scale of listed firms issuing green bonds. *Turnover*, measured by fixed asset turnover, has a mean of 2.047 and a standard deviation of 2.819, suggesting considerable heterogeneity in operating efficiency across issuers. *ROE* has a mean value of 0.021, indicating moderate profitability. The mean value of *SOE* is 0.696, showing that state-owned enterprises account for a large proportion of green bond issuers in the sample, which is consistent with the policy-oriented nature of China's green bond market.

Regarding bond-level characteristics, the mean value of *Redeemable* is 0.099, indicating that approximately 9.9% of the sampled green bonds contain redeemable clauses. The mean value of *Rating* is 3.486, suggesting that the sample bonds generally have high credit ratings, mostly between AA+ and AAA. *Amount*, measured as the bond issuance scale in billions of RMB, has a mean of 2.385 and a standard deviation of 5.194, reflecting substantial variation in issuance size. *Maturity*, measured as the natural logarithm of bond maturity in years, has a mean of 1.006 and a standard deviation of 1.079, indicating substantial variation in bond tenors across green bond issuances. Finally, *GDP*, measured as the GDP growth rate of the city where the issuer is located, has a mean of 4.856, capturing differences in local macroeconomic conditions across issuers.

5.2 Pearson correlation

Table 3 reports the Pearson correlation coefficients among the main variables. The correlation matrix provides preliminary evidence on the bivariate relationships before conducting multivariate regression analyses. As expected, *CDT* is significantly and negatively correlated with *Spread* at the 1% level, with a coefficient of −0.325. This provides initial evidence consistent with Hypothesis 1, suggesting that firms with higher levels of digital transformation tend to have lower green bond financing costs. Several control variables also exhibit expected correlations with *Spread*. For example, *Leverage*, *Size*, *Rating*, and *Amount* are significantly negatively associated with *Spread*, indicating that issuer characteristics and bond-specific features are related to green bond pricing. However, these pairwise correlations should be interpreted with caution because they do not control for other firm-level, bond-level, macroeconomic, or fixed-effect factors. Therefore, multivariate regression analyses are required to provide more rigorous evidence on the relationship between *CDT* and *Spread*. The correlations among the explanatory variables are generally within an acceptable range. Although some variables show moderate correlations, such as the correlation between *Leverage* and *Size*, the variance inflation factor (VIF) values reported in the last column are all well below conventional thresholds. The highest VIF is 2.856 for *Size*, indicating that multicollinearity is unlikely to materially affect the subsequent regression results.

5.3 Baseline regression results

Table 4 presents the baseline results of CDT on the financing cost of green bonds. Column (1) shows the result without control variables and fixed effects and column (2) considers control variables without applying fixed effects. Column (3) only controls for industry and year fixed effects. Column (4) accounts for all control variables and fixed effects. In the fully specified model, the coefficient of *CDT* is −0.283 and significant at the 1% level. Based on the four regression settings, the negative coefficient of *CDT* on the financing cost of green bond shows high robustness. These findings suggest that corporate digital transformation can lower the financing cost of green bonds, thereby validating Hypothesis 1.

5.4 Robustness testing

5.4.1 Alternative measurement of CDT and the financing cost of green bond. Following Zhang *et al.* (2025), this study adopts the digital transformation index from the "China Listed Companies Digital Transformation Research Database" in the CSMAR database as an

Table 3. Pearson correlation

	Spread	CDT	Leverage	Size	Turnover	ROE	SOE	Redeemable	Rating	Amount	Maturity	GDP	VIF
Spread	1												/
CDT	-0.325^{***}	1											/
Leverage	-0.182^{***}	0.628^{***}	1										2.403
Size	-0.446^{***}	0.561^{***}	0.676^{***}	1									2.856
Turnover	0.093^{**}	0.230^{***}	0.168^{***}	-0.082^{*}	1								1.309
ROE	−0.071	0.058	0.153^{***}	0.186^{***}	−0.002	1							1.114
SOE	−0.062	-0.316^{***}	-0.207^{***}	-0.128^{***}	-0.294^{***}	-0.124^{***}	1						1.308
Redeemable	0.004	−0.004	−0.016	−0.025	0.033	−0.065	0.070	1					1.078
Rating	-0.264^{***}	0.038	0.038	0.246^{***}	-0.152^{***}	0.026	0.049	0.104^{**}	1				1.188
Amount	-0.208^{***}	0.345^{***}	0.415^{***}	0.596^{***}	-0.087^{**}	0.204^{***}	-0.282^{***}	-0.082^{*}	0.194^{***}	1			1.728
Maturity	0.016	0.254^{***}	0.282^{***}	0.157^{***}	0.196^{***}	0.012	-0.117^{***}	0.162^{***}	-0.183^{***}	0.077^{*}	1		1.227
GDP	0.048	0.060	0.131^{***}	0.084^{*}	-0.106^{**}	0.200^{***}	0.047	-0.077^{*}	−0.064	0.051	0.125^{***}	1	1.109

Note(s): This table reports Pearson correlation coefficients among the main variables. VIF denotes variance inflation factor. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

Source(s): Author’s own work

Table 4. Effects of CDT on financing cost of green bond

	(1) Spread	(2) Spread	(3) Spread	(4) Spread
CDT	−0.227***	−0.207***	−0.306***	−0.283***
	(−7.77)	(−5.94)	(−6.99)	(−6.97)
Leverage		1.460***		−0.058
		(5.79)		(−0.13)
Size		−0.208***		−0.086**
		(−7.36)		(−2.49)
Turnover		0.007		−0.003
		(0.48)		(−0.15)
ROE		−2.229		−0.163
		(−0.90)		(−0.09)
SOE		−0.235***		−0.026
		(−2.77)		(−0.29)
Redeemable		0.058		0.079
		(0.62)		(0.95)
Rating		−0.110**		−0.092**
		(−2.46)		(−2.14)
Amount		0.010**		−0.004
		(2.08)		(−0.62)
Maturity		0.021		−0.027
		(0.84)		(−1.27)
GDP		0.021*		−0.030
		(1.71)		(−1.60)
Constant	1.390***	6.181***	1.563***	4.347***
	(16.42)	(9.74)	(14.11)	(5.08)
Industry	NO	NO	YES	YES
Year	NO	NO	YES	YES
Observations	533	533	526	526
Adj. R^2	0.104	0.290	0.484	0.508

Note(s): This table presents the impact of *CDT* on *Spread*. Definitions of variables are detailed in Table 2. Firm-clustered robust *t*-values are provided in parentheses. The inclusion of industry and year fixed effects is reported at the bottom of the table. *, **, and *** denote significance levels at 10%, 5%, and 1%, respectively (two-tailed tests)

Source(s): Author's own work

alternative measure of CDT (*CDT_new*). In line with Tang *et al.* (2023) and Yuan *et al.* (2025), the new bond spread (*Spread_new*) is calculated using the yield of China Development Bank (CDB) bonds with matched maturities as the benchmark [5]. Compared to treasury bonds of the same term, CDB bonds also carry minimal risk and benefit from sovereign-level credit endorsement and high liquidity, though they are not tax-exempt.

Columns (1)–(3) of Table 5 report the results based on alternative variable measurements. In Column (1), both the dependent variable and the key explanatory variable are replaced by their alternative measures. The coefficient of *CDT_new* is −0.019 and statistically significant at the 1% level, indicating that firms with higher levels of digital transformation continue to face lower green bond financing costs when both key variables are redefined. Column (2) uses *Spread_new* as the dependent variable while retaining the original *CDT* measure. The coefficient of *CDT* remains negative and significant at the 10% level, suggesting that the baseline conclusion is not driven by the choice of the risk-free benchmark. Column (3) retains the original *Spread* measure but replaces the explanatory variable with *CDT_new*. The coefficient of *CDT_new* is −0.015 and significant at the 1% level. Overall, these results show that the negative relationship between CDT and green bond financing costs remains robust under alternative measurements of both the dependent and independent variables.

Table 5. Robustness test

	Alternative measurement method			Entropy balance method	Instrumental variable method	
	(1) Spread_new	(2) Spread_new	(3) Spread	(4) Spread	(5) CDT	(6) Spread
CDT		−0.082*		−0.187***		−0.703***
		(−1.71)		(−7.20)		(−4.76)
CDT_new	−0.019***		−0.015***			
	(−4.23)		(−4.12)			
Leverage	0.537	0.550	0.222	−0.232	−1.236	2.810***
	(1.04)	(1.00)	(0.47)	(−0.21)	(−1.61)	(4.36)
Size	−0.107***	−0.106**	−0.121***	0.012	0.213***	−0.104**
	(−2.65)	(−2.58)	(−3.23)	(0.32)	(4.20)	(−2.51)
Turnover	0.020	0.029	−0.011	−0.009	0.019	0.034*
	(0.92)	(1.17)	(−0.65)	(−0.57)	(0.97)	(1.75)
ROE	−0.288	−0.732	−0.190	−2.408	3.785**	−4.933*
	(−0.13)	(−0.32)	(−0.10)	(−1.36)	(1.97)	(−1.94)
SOE	0.043	0.001	0.066	−0.010	−0.296**	−0.444***
	(0.39)	(0.01)	(0.71)	(−0.16)	(−2.55)	(−3.82)
Redeemable	0.382***	0.339***	0.107	0.113	0.001	0.066
	(3.05)	(2.59)	(1.25)	(1.23)	(0.01)	(0.61)
Rating	−0.192***	−0.190***	−0.091**	−0.050	−0.023	−0.117**
	(−3.55)	(−3.48)	(−2.04)	(−1.21)	(−0.73)	(−2.51)
Amount	0.008	0.005	0.000	−0.016**	−0.008	0.008
	(1.35)	(0.76)	(0.01)	(−2.26)	(−0.75)	(1.11)
Maturity	−0.228***	−0.249***	−0.011	−0.098***	−0.000	0.049*
	(−5.75)	(−6.48)	(−0.49)	(−3.03)	(−0.01)	(1.68)
GDP	−0.012	−0.009	−0.035*	−0.083***	0.008	0.024*
	(−0.63)	(−0.47)	(−1.82)	(−3.46)	(0.38)	(1.75)
IV					0.016***	
					(2.97)	
Constant	4.839***	4.312***	4.919***	1.910***	−2.961*	3.731***
	(4.93)	(4.35)	(5.24)	(2.95)	(−1.87)	(4.11)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen−Paap rk LM statistic	–				26.583	
Cragg-Donald Wald F statistic	–				49.095	
Stock-Yogo	–				16.380	
Observations	526	526	526	526	526	526
Adj. R^2	0.411	0.389	0.473	0.563	0.677	0.029

Note(s): This table reports the robustness test results for the relationship between CDT and green bond financing costs. Columns (1)–(3) use alternative measurements of the main variables; Column (4) reports the entropy balancing result; and Columns (5)–(6) report the instrumental variable estimation results. Definitions of variables are detailed in Table 2. Industry and year fixed effects are controlled in all regressions. Robust *t*-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively
Source(s): Author's own work

5.4.2 Entropy balancing. To further address potential covariate imbalance, this study employs entropy balancing as a reweighting approach. Entropy balancing directly adjusts the weights of control observations to match the covariate moments of the treated group, thereby improving balance quality and reducing model dependence (Hainmueller, 2012). After reweighting, the weighted control group closely matches the treated group across the selected covariates. Column (4) of Table 5 reports the entropy-weighted regression result. The coefficient of *CDT* remains significantly negative ($\beta = -0.187$), indicating that the baseline conclusion is robust after accounting for observable covariate imbalance. This result provides further support for Hypothesis 1.

5.4.3 Instrumental variable. To address potential endogeneity concerns arising from unobserved confounders and possible reverse causality, a two-stage least squares (2SLS) estimation is employed with an instrumental variable. Following Zhou and Li (2023), the internet penetration rate at the prefecture-city level is used as an instrument. This variable satisfies the relevance condition, as local internet infrastructure directly affects firms' technological foundation and implementation costs for digital transformation, while also meeting the exclusion restriction, since it is a regional infrastructure indicator unlikely to directly influence firm-level bond financing costs. Columns (5) and (6) of Table 5 report the instrumental variable estimation results. Column (5) presents the first-stage regression, where the coefficient of the instrumental variable is positive and statistically significant at the 1% level. This result confirms the relevance of the instrument. In addition, the Kleibergen-Paap rk LM statistic is 26.583, rejecting the null hypothesis of under-identification. The Cragg-Donald Wald F statistic is 49.095, which is well above the Stock-Yogo critical value of 16.380, indicating that weak-instrument concerns are unlikely to be severe. Column (6) presents the second-stage regression results. After accounting for potential endogeneity, the coefficient of *CDT* remains significantly negative. This finding is consistent with the baseline regression and further supports Hypothesis 1, indicating that CDT reduces the financing cost of green bonds after addressing potential endogeneity concerns.

5.5 Further analysis

5.5.1 Channel analysis. To further examine the mechanisms through which CDT reduces green bond financing costs, this study investigates two channels derived from the theoretical framework: the information transparency channel and the governance and agency channel. Specifically, environmental information disclosure quality (*Envir*) is used to capture the information transparency channel (Fan *et al.*, 2024), while internal control quality (*Internal*) is used to capture the governance and agency channel (Chen *et al.*, 2025).

Columns (1) and (2) of Table 6 report the results for the information transparency channel. Column (1) shows that the coefficient of *CDT* is positive and statistically significant at the 1% level, indicating that firms with higher levels of digital transformation tend to have better environmental information disclosure quality. This finding is consistent with the argument that digital technologies enhance firms' ability to collect, process, and disclose environmental and project-level information in a more timely, traceable, and verifiable manner (Asif *et al.*, 2023). Column (2) further includes *Envir* in the spread regression. The coefficient of *Envir* is significantly negative, suggesting that higher-quality environmental information disclosure is associated with lower green bond financing costs. Meanwhile, the coefficient of *CDT* remains negative and significant, indicating a partial transmission effect. These results support the information transparency channel: CDT reduces green bond spreads partly by improving the credibility and transparency of environmental information disclosure. Columns (3) and (4) report the results for the governance and agency channel. Column (3) shows that *CDT* is positively associated with *Internal* at the 1% significance level, suggesting that digital transformation helps strengthen internal control quality. This is consistent with the view that digital technologies improve process standardization, internal monitoring, and the traceability of fund allocation and project implementation (Zhao *et al.*, 2023). Column (4) shows that the coefficient of *Internal* is significantly negative, indicating that stronger internal control quality reduces green bond financing costs. The coefficient of *CDT* remains negative and significant after controlling for *Internal*, suggesting that internal control quality partially channels the effect of CDT on green bond spreads.

Overall, the results in Table 6 provide evidence consistent with both proposed mechanisms. CDT lowers the financing cost of green bonds not only by improving environmental

Table 6. Channel analysis

	(1) Envir	(2) Spread	(3) Internal	(4) Spread
CDT	0.175***	−0.281***	0.020***	−0.275***
	(3.66)	(−4.82)	(3.28)	(−4.48)
Leverage	−0.313	−0.155	−0.319***	−0.716
	(−0.66)	(−0.30)	(−4.11)	(−1.28)
Size	0.124***	−0.077**	0.004	−0.104***
	(4.27)	(−2.06)	(0.98)	(−2.95)
Turnover	−0.016	−0.005	−0.000	−0.007
	(−1.20)	(−0.25)	(−0.16)	(−0.32)
ROE	7.522***	0.147	1.845***	1.524
	(4.34)	(0.08)	(10.03)	(0.81)
SOE	−0.144**	−0.012	0.019	0.002
	(−2.07)	(−0.12)	(1.31)	(0.02)
Redeemable	−0.203**	0.059	−0.009	0.022
	(−2.32)	(0.65)	(−0.91)	(0.24)
Rating	0.049***	−0.076*	0.005	−0.027
	(2.67)	(−1.69)	(1.25)	(−0.76)
Amount	−0.014***	−0.005	0.003**	0.002
	(−2.72)	(−0.72)	(2.37)	(0.27)
Maturity	−0.049**	−0.040*	0.019***	0.009
	(−2.13)	(−1.65)	(5.67)	(0.37)
GDP	0.019	−0.028	−0.003	−0.039*
	(1.54)	(−1.33)	(−1.39)	(−1.87)
Envir		−0.128**		
		(−2.32)		
Internal				−1.068**
				(−2.54)
Constant	−1.166*	4.445***	6.466***	11.944***
	(−1.75)	(4.59)	(61.92)	(3.83)
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
Observations	480	480	450	450
Adj. R^2	0.467	0.501	0.459	0.554

Note(s): This table reports the channel analysis of the relationship between CDT and green bond financing costs. Columns (1) and (2) examine the information transparency channel through environmental information disclosure quality (*Envir*), while Columns (3) and (4) examine the governance and agency channel through internal control quality (*Internal*). Industry and year fixed effects are controlled in all regressions. Robust *t*-values are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Source(s): Author's own work

information disclosure quality, but also by strengthening internal control quality. These findings support the theoretical prediction that digital transformation reduces green-specific information and governance risks priced by investors in the green bond market.

5.5.2 Sobel and bootstrap test. To further examine the statistical significance of the proposed channels, this study conducts Sobel and bootstrap mediation tests. The Sobel test assesses whether the indirect effect of CDT on green bond financing costs through each mediator is significantly different from zero, while the bootstrap test provides confidence intervals without relying on the normality assumption. Panel A of Table 7 reports the Sobel test results. For the information transparency channel, the indirect effect through environmental information disclosure quality (*Envir*) is −0.0223, with a Sobel z-statistic of −1.9605 and a *p*-value of 0.0499. For the governance and agency channel, the indirect effect through internal control quality (*Internal*) is −0.0218, with a Sobel z-statistic of −2.0092 and a *p*-value of

Table 7. Sobel and bootstrap mediation tests

Panel A: Sobel test results

Channel	a_path	b_path	Indirect effect	Sobel SE	Sobel z-statistic	*p*-value	Direct effect	Total effect	Mediation ratio
Envir	0.1749	−0.1275	−0.0223	0.0114	−1.9605	0.0499	−0.2815	−0.3038	0.0734
Internal	0.0204	−1.0675	−0.0218	0.0109	−2.0092	0.0445	−0.2753	−0.2971	0.0734

Panel B: bootstrap test results

Channel	Effect	Point_Estimate	Bootstrap_SE	95% CI lower	95% CI upper
Envir	Indirect effect	−0.0223	0.0117	−0.0455	−0.0001
Envir	Direct effect	−0.2815	0.0637	−0.4220	−0.1715
Envir	Total effect	−0.3038	0.0621	−0.4420	−0.1954
Envir	Mediation ratio	0.0734	0.0435	0.0004	0.1780
Internal	Indirect effect	−0.0218	0.0121	−0.0480	−0.0006
Internal	Direct effect	−0.2753	0.0700	−0.4316	−0.1668
Internal	Total effect	−0.2971	0.0716	−0.4610	−0.1798
Internal	Mediation ratio	0.0734	0.0392	0.0024	0.1535

Note(s): This table reports the Sobel and bootstrap mediation tests for the two proposed channels. *Envir* denotes environmental information disclosure quality, and *Internal* denotes internal control quality. Panel A presents the Sobel test results, while Panel B reports bootstrap results based on 500 replications. The 95% confidence intervals are reported in the last two columns

Source(s): Author's own work

0.0445. Both indirect effects are significant at the 5% level. Panel B presents the bootstrap results based on 500 replications. The 95% confidence interval for the indirect effect through *Envir* is [−0.0455, −0.0001], while that for *Internal* is [−0.0480, −0.0006]. Since both intervals exclude zero, the bootstrap results further support the significance of the two mediation channels. The direct effects remain negative after including the mediators, indicating partial mediation. These results suggest that CDT reduces green bond financing costs partly by improving environmental information disclosure quality and strengthening internal control quality, thereby supporting the information transparency channel and the governance and agency channel.

6. Conclusion

Against the background of global decarbonization and the rapid development of sustainable finance, this study examines whether CDT reduces the financing cost of green bonds. Using firm-bond observations of Chinese A-share listed companies from 2016 to 2024, this paper shows that CDT is significantly and negatively associated with green bond credit spreads. This evidence suggests that digitally transformed firms can obtain green financing at lower costs.

The baseline finding remains robust after controlling for firm-level characteristics, bond-level features, local macroeconomic conditions, and industry and year fixed effects. It also holds under alternative measurements of CDT and green bond spreads, entropy balancing, and instrumental-variable estimation. These results provide consistent support for the view that CDT is an important firm-level determinant of green bond financing costs. The mechanism analysis further indicates that CDT affects green bond pricing through two channels. First, CDT improves environmental information disclosure quality, thereby reducing information asymmetry and enhancing the credibility of green claims. Second, CDT strengthens internal control quality, which improves the traceability of fund allocation and mitigates agency concerns related to green bond proceeds. Sobel and bootstrap tests provide additional evidence that these two channels partially mediate the relationship between CDT and green bond spreads.

This study contributes to the literature in three ways. First, it extends research on the economic consequences of CDT from internal operations and conventional capital markets to sustainable finance. Second, it adds to the green bond pricing literature by identifying digital transformation as a firm-level strategic capability that helps explain cross-sectional variation in green bond financing costs. Third, it clarifies why green bonds warrant separate examination from general corporate bonds: their pricing reflects not only credit risk, but also environmental credibility, use-of-proceeds integrity, post-issuance monitoring, and greenwashing concerns. The findings also offer practical implications. For policymakers, the results suggest that digital infrastructure can complement green finance regulation by improving the transparency and monitorability of green projects. For firms, digital transformation is not merely a technological upgrade, but also a financing-relevant capability that can reduce the cost of green capital. For investors, CDT may serve as an additional signal when evaluating the credibility of environmental disclosures and the governance quality of green bond issuers.

This study has several limitations. The text-based CDT measure captures firms' digital orientation disclosed in annual reports, but may not fully reflect the depth or effectiveness of actual digital implementation. Future research could use more granular indicators, such as digital patents, digital capital investment, IT human capital, or project-level digital infrastructure. In addition, although this study uses entropy balancing and instrumental-variable estimation to mitigate endogeneity concerns, future work could further exploit quasi-natural experiments or project-level data. Finally, the evidence is based on China's green bond market. Comparative studies across different institutional settings would help assess the broader generalizability of the findings.

In sum, this study shows that corporate digital transformation helps reduce the financing cost of green bonds by alleviating green-specific information and agency frictions. As digitalization and decarbonization increasingly converge, firms' digital capabilities are likely to become an important factor shaping sustainable finance outcomes.

About the author
Zhufeng Huang is a current student at University of Technology Sydney, majoring in finance. His current research interests include green finance, sustainable development, and digital economy. His work has been published in SSCI journals such as *Total Quality Management and Business Excellence*.

Data availability statement
Data available on request from the author.

Notes

1. *Sustainable Debt Global State of the Market 2024.* https://www.climatebonds.net/files/documents/publications/Climate-Bonds-Initiative_Global-State-of-the-Market-Report_May-2025.pdf
2. *China's Green Bond Issuance and Investment Opportunity Report* released by Climate Bonds Initiative mentions the development of China's green bond situation from 2016 to 2019. https://www.climatebonds.net/files/documents/publications/China's-Green-Bond-Issuance-and-Investment-Opportunity.pdf
3. The *White Paper on Green Bonds in China*, released by China Central Depository & Clearing Co., Ltd., provides important guidance for understanding the development of China's green bond market. https://www.chinabond.com.cn/chinaBond_en/A147286398/A147287965/A147288139/202508/P020250908589610626958.pdf
4. *Digital China Development Report in 2024* by National Data Administration. https://www.nda.gov.cn/sjj/ywpd/sjzg/0530/ff808081-96b465bf-0197-200a135e-0536.pdf
5. The data of CDB bonds is sourced from the official website of CDB: https://yield.chinabond.com.cn/gkh/yield

References

Ajakwe, I.U., Ajakwe, S.O., Lee, J.-M. and Kim, D.-S. (2025), "Internet-of-things-blockchain integration in environmental pollution monitoring data management: trends and techniques", *International Journal of Environmental Science and Technology*, Vol. 22 No. 15, pp. 16123-16142, doi: 10.1007/s13762-025-06615-x.

Ambec, S. and Lanoie, P. (2008), "Does it pay to be green? A systematic overview", *Academy of Management Perspectives*, Vol. 22 No. 4, pp. 45-62, doi: 10.5465/amp.2008.35590353.

Asif, M., Searcy, C. and Castka, P. (2023), "ESG and industry 5.0: the role of technologies in enhancing ESG disclosure", *Technological Forecasting and Social Change*, Vol. 195, 122806, doi: 10.1016/j.techfore.2023.122806.

Chen, M., Zhao, K. and Jin, W. (2024), "Corporate digital transformation and tax avoidance: evidence from China", *Pacific-Basin Finance Journal*, Vol. 85, 102400, doi: 10.1016/j.pacfin.2024.102400.

Chen, W., Ren, H. and Huang, Z. (2025), "Does carbon emission trading system facilitate corporate digital transformation? Evidence from China", *Total Quality Management and Business Excellence*, Vol. 36 Nos 11-12, pp. 1301-1329, doi: 10.1080/14783363.2025.2548600.

Dou, X. and Qi, S. (2019), "The choice of green bond financing instruments", *Cogent Business and Management*, Vol. 6 No. 1, 1652227, doi: 10.1080/23311975.2019.1652227.

Dou, B., Guo, S.L., Chang, X.C. and Wang, Y. (2023), "Corporate digital transformation and labor structure upgrading", *International Review of Financial Analysis*, Vol. 90, 102904, doi: 10.1016/j.irfa.2023.102904.

Fan, X., Tang, Z., Fu, Y. and Yan, J. (2024), "Environmental information disclosure and corporate financial performance: evidence from China", *Accounting and Finance*, Vol. 64 No. Suppl. 1, pp. 5039-5068, doi: 10.1111/acfi.13327.

Fang, X. and Liu, M. (2024), "How does the digital transformation drive digital technology innovation of enterprises? Evidence from enterprise's digital patents", *Technological Forecasting and Social Change*, Vol. 204, 123428, doi: 10.1016/j.techfore.2024.123428.

Flammer, C. (2021), "Corporate green bonds", *Journal of Financial Economics*, Vol. 142 No. 2, pp. 499-516, doi: 10.1016/j.jfineco.2021.01.010.

Hainmueller, J. (2012), "Entropy balancing for causal effects: a multivariate reweighting method to produce balanced samples in observational studies", *Political Analysis*, Vol. 20 No. 1, pp. 25-46, doi: 10.1093/pan/mpr025.

He, J., Du, X.D. and Tu, W. (2024), "Can corporate digital transformation alleviate financing constraints?", *Applied Economics*, Vol. 56 No. 20, pp. 2434-2450, doi: 10.1080/00036846.2023.2187037.

Hu, X., Zhong, A. and Cao, Y. (2022), "Greenium in the Chinese corporate bond market", *Emerging Markets Review*, Vol. 53, 100946, doi: 10.1016/j.ememar.2022.100946.

Huang, C., Mirza, S.S., Zhang, C. and Miao, Y. (2025), "Corporate digital transformation and audit signals: building trust in the digital age", *Meditari Accountancy Research*, Vol. 33 No. 2, pp. 553-587, doi: 10.1108/MEDAR-10-2023-2187.

International Capital Market Association (2021), "The green bond principles", available at: https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/

Jensen, M.C. and Meckling, W.H. (1976), "Theory of the firm: managerial behavior, agency costs and ownership structure", *Journal of Financial Economics*, Vol. 3 No. 4, pp. 305-360, doi: 10.1016/0304-405X(76)90026-X.

Jian, J., Fan, X. and Zhao, S. (2022), "The green incentives and green bonds financing under the belt and road initiative", *Emerging Markets Finance and Trade*, Vol. 57, pp. 13-28, doi: 10.1080/1540496X.2021.1887726.

Jiang, W. and Li, J. (2024), "Digital transformation and its effect on resource allocation efficiency and productivity in Chinese corporations", *Technology in Society*, Vol. 78, 102638, doi: 10.1016/j.techsoc.2024.102638.

Jiang, K., Xie, X., Xiao, Y. and Ashraf, B.N. (2025), "The value of corporate digital transformation: evidence from bond pricing", *China Finance Review International*, Vol. 15 No. 1, pp. 43-66, doi: 10.1108/CFRI-05-2024-0241.

Li, Z.Y., Tang, Y., Wu, J.Y., Zhang, J.F. and Lv, Q. (2020), "The interest costs of green bonds: credit ratings, corporate social responsibility, and certification", *Emerging Markets Finance and Trade*, Vol. 56 No. 12, pp. 2679-2692, doi: 10.1080/1540496X.2018.1548350.

Li, Y., Zheng, Y., Li, X. and Mu, Z. (2024a), "The impact of digital transformation on ESG performance", *International Review of Economics and Finance*, Vol. 96, 103686, doi: 10.1016/j.iref.2024.103686.

Li, Z., Xie, B., Chen, X. and Fu, Q. (2024b), "Corporate digital transformation, governance shifts and executive pay-performance sensitivity", *International Review of Financial Analysis*, Vol. 92, 103060, doi: 10.1016/j.irfa.2023.103060.

Liu, E.X. and Dang, L. (2025), "Digital transformation and debt financing cost: a threefold risk perspective", *Journal of Financial Stability*, Vol. 76, 101368, doi: 10.1016/j.jfs.2024.101368.

Liu, Z., Chen, Z. and Hu, L. (2024), "Can enterprise digital transformation improve ESG performance?", *Managerial and Decision Economics*, Vol. 45 No. 7, pp. 5088-5103, doi: 10.1002/mde.4307.

Lu, C., Zhao, Y., Xing, K. and Liu, J. (2025), "Digital transformation and corporate fraud: evidence from China", *International Review of Financial Analysis*, Vol. 106, 104476, doi: 10.1016/j.irfa.2025.104476.

Peng, Q. and Xie, Y. (2024), "ESG greenwashing and corporate debt financing costs", *Finance Research Letters*, Vol. 69 No. Part A, 106012, doi: 10.1016/j.frl.2024.106012.

Ross, S.A. (1977), "The determination of financial structure: the incentive-signalling approach", *The Bell Journal of Economics*, Vol. 8 No. 1, pp. 23-40, doi: 10.2307/3003485.

Sheng, Q., Zheng, X. and Zhong, N. (2021), "Financing for sustainability: empirical analysis of green bond premium and issuer heterogeneity", *Natural Hazards*, Vol. 107 No. 3, pp. 2641-2651, doi: 10.1007/s11069-021-04540-z.

Song, Y., Du, C., Du, P., Liu, R. and Lu, Z. (2024), "Digital transformation and corporate environmental performance: evidence from Chinese listed companies", *Technological Forecasting and Social Change*, Vol. 201, 123159, doi: 10.1016/j.techfore.2023.123159.

Spence, M. (1973), "Job market signaling", *Quarterly Journal of Economics*, Vol. 87 No. 3, pp. 355-374, doi: 10.2307/1882010.

Sui, B. and Yao, L.Y. (2023), "The impact of digital transformation on corporate financialization: the mediating effect of green technology innovation", *Innovation and Green Development*, Vol. 2 No. 1, 100032, doi: 10.1016/j.igd.2022.100032.

Sun, Z., Zhao, L., Mehrotra, A., Salam, M.A. and Yaqub, M.Z. (2025), "Digital transformation and corporate green innovation: an affordance theory perspective", *Business Strategy and the Environment*, Vol. 34 No. 1, pp. 433-449, doi: 10.1002/bse.3991.

Tang, Y., Wang, B., Pan, N. and Li, Z. (2023), "The impact of environmental information disclosure on the cost of green bond: evidence from China", *Energy Economics*, Vol. 126, 107008, doi: 10.1016/j.eneco.2023.107008.

Wang, J., Chen, X., Li, X., Yu, J. and Zhong, R. (2020), "The market reaction to green bond issuance: evidence from China", *Pacific-Basin Finance Journal*, Vol. 60, 101294, doi: 10.1016/j.pacfin.2020.101294.

Wang, S., Wen, W., Niu, Y.H. and Li, X. (2024), "Digital transformation and corporate labor investment efficiency", *Emerging Markets Review*, Vol. 59, 101109, doi: 10.1016/j.ememar.2024.101109.

Wang, Y., Tang, J. and Li, C. (2025), "How does digital transformation affect corporate resilience: a moderation perspective study", *Applied Economics*, Vol. 57 No. 2, pp. 121-134, doi: 10.1080/00036846.2024.2350700.

Wu, F., Hu, H., Lin, H. and Ren, X. (2021), "Enterprise digital transformation and capital market performance: empirical evidence from stock liquidity", *Management World*, Vol. 37 No. 7, pp. 130-144, doi: 10.19744/j.cnki.11-1235/f.2021.0097.

Wu, W., Zhou, H. and Huo, Z. (2025), "The effect of issuers' digital transformation on bond rating quality: evidence from China's bond market", *Research in International Business and Finance*, Vol. 79, 103098, doi: 10.1016/j.ribaf.2025.103098.

Xue, Y. and Yun, X.Y. (2024), "The impact of collateral-based monetary policy on green financing cost: an analysis of the People's bank of China's approach", *Climate Policy*, Vol. 24 No. 7, pp. 909-923, doi: 10.1080/14693062.2024.2356811.

Ye, X. and Miao, L. (2025), "Digital transformation and green finance efficiency of tourism enterprises: the effect of credit ratings", *International Review of Financial Analysis*, Vol. 106, 104527, doi: 10.1016/j.irfa.2025.104527.

Yuan, H., Liao, J. and Young, M. (2025), "The impact of the carbon trading pilot program on the financing cost of green bonds", *Finance Research Letters*, Vol. 78, 107203, doi: 10.1016/j.frl.2025.107203.

Zhang, X., Yue, S., Tao, J. and Lai, X. (2025), "Does digital transformation affect corporate mergers and acquisitions? From the perspective of information asymmetry", *Economic Analysis and Policy*, Vol. 86, pp. 764-778, doi: 10.1016/j.eap.2025.03.049.

Zhao, T.Y., Yan, N. and Ji, L.Y. (2023), "Digital transformation, life cycle and internal control effectiveness: evidence from China", *Finance Research Letters*, Vol. 58 No. Part A, 104223, doi: 10.1016/j.frl.2023.104223.

Zheng, Y. and Zhang, Q. (2023), "Digital transformation, corporate social responsibility and green technology innovation—based on empirical evidence of listed companies in China", *Journal of Cleaner Production*, Vol. 424, 138805, doi: 10.1016/j.jclepro.2023.138805.

Zhou, B. and Gao, H. (2026), "The impact of environmental information disclosure on the credit spread of green bonds: empirical evidence from China", *Emerging Markets Finance and Trade*, pp. 1-22, doi: 10.1080/1540496X.2026.2615813.

Zhou, Z. and Li, Z. (2023), "Corporate digital transformation and trade credit financing", *Journal of Business Research*, Vol. 160, 113793, doi: 10.1016/j.jbusres.2023.113793.

Zhou, Z. and Zhang, J. (2025), "Manufacturing enterprise digital transformation, financial flexibility, and financial risk—Evidence from China", *International Review of Financial Analysis*, Vol. 104, 104279, doi: 10.1016/j.irfa.2025.104279.

Zirek, D. and Unsal, O. (2023), "Green bonds: do investors benefit from third-party certification?", *Global Finance Journal*, Vol. 58, 100872, doi: 10.1016/j.gfj.2023.100872.

Corresponding author
Zhufeng Huang can be contacted at: everest_huang@163.com