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Trade credit and corporate digital transformation: The role of managerial ability

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Abstract

We examine whether managerial ability affects the relationship between corporate digital transformation and trade credit. To measure digital transformation, we perform a textual analysis of companies' annual reports using a customized Chinese dictionary containing digital transformation keywords based on national policy documents and academic literature. Using 10,554 observations from 2509 A-shares listed companies in China, we show that corporate digital transformation has significantly impacted trade credit. Managerial ability enhances the relationship between digital transformation and received trade credit but does not change the impact between digital transformation and provided trade credit. A battery of robustness tests confirms the findings.

KEYWORDS
digital transformation, managerial ability, trade credit

JEL CLASSIFICATION
D80, G30, G32, M12

1 | INTRODUCTION

Trade credit plays an important role in a short-term liquidity provision and it has been widely discussed in the literature (Jory et al., 2020; Kong et al., 2020; Shang, 2020). In developed countries, like the United States, the accounts receivable of non-financial services listed companies accounted for 16.4% of total sales during the 1950–2019 period (Cao et al., 2022), whereas in developing countries, such as China, the accounts payable of listed companies accounted for 8.2% of total assets during the 2007–2018 period (Wu et al., 2021). As a dominant source of short-term external financing for companies (Bougheas et al., 2009; Elsilä, 2015) and as a competitive tool (Fabbri & Klapper, 2016), trade credit is essential for effective business management decisions (Atanasova, 2007).

The most recent research papers that have examined trade credit focus on the firm-specific determinants of its use or the impact of economic factors on trade credit (D'Mello & Toscano, 2020). It was found that medium, small, and micro firms employ trade credit more extensively during financial crises (Carbó-Valverde et al., 2016). Love et al. (2007) show the increase in trade credit during the extreme financial market turmoil, while Kling et al. (2014), on the contrary, indicate that trade credit given by suppliers decreases during the financial crisis. Recent studies by D'Mello and Toscano (2020) and Jory et al. (2020) suggest that economic policy uncertainty is negatively related to trade credit. Hasan and Habib (2019) further argue that firms located in highly social areas are using trade credit less frequently. Kong et al. (2020) demonstrate the hometown association of the CEO with the supplier significantly increases access to trade credit via information as well as social trust. Moreover, the effect between state ownership and trade credit provision is confirmed to be positive by Chen et al. (2021), where more trade credit is being used by non-state-owned firms for financing purposes (Ge & Qiu, 2007). Consequently, the directions of trade credit are mainly composed of obtaining trade credit from suppliers and providing trade credit to customers (Hill et al., 2012), which can effectively curb firms' carbon emissions (An et al., 2021), affect firm profitability (Baker et al., 2022), and enhances efficiency (Agostino & Trivieri, 2019). Specifically, Baker et al. (2022) proposed that maintaining certain levels of accounts receivable can increase the operating profit of enterprises, and providing trade credit to customers helps to increase the wealth of shareholders and obtain strategic benefits.

Recognizing the value of trade credit to companies, it is essential to explore its new drivers and consequences, especially in the digital transformation era, which has significant implications for individuals, organizations, and society (Liu & Wang, 2023; Vial, 2019). The definition of digital transformation refers to the utilization of new digital technologies such as information and communications technology, big data, artificial intelligence, cloud computing, blockchain, and the Internet of Things (IoT) to realize remarkable business improvements, enhance customer experience, streamline operations, and generate new business models (Warner & Wager, 2019). Research on digital transformation is spreading at an extraordinary rate in both academic and practical circles (Wessel et al., 2021). Firms that fail to adapt to digital technologies may be overtaken or even replaced by new entrants (Verhoef et al., 2021). The rapid proliferation of digital transformation has led to new changes that often involve the transformation of key business operations and processes. Moreover, scholars have shown that digitalization can have an observable impact on firms' financial performance (Verhoef et al., 2021), innovation (Urbinati et al., 2020), and business models (Ferreira et al., 2019). However, research on the impacts of digital transformation on trade credit is still scarce (Liu & Wang, 2023), and in this paper we aim to fill this gap in the literature.

Chen et al. (2022) explored its impact on the information environment, revealing that digital transformation enhances public information accuracy and analyst coverage. While there was no significant change in private information accuracy, the study illuminated the channels through which digital transformation influences analyst behavior, including information disclosure quality and stock price information content. This insight aligns with Wu et al. (2022a), demonstrating the risk-reducing effect of digital transformation on stock price crashes, particularly in high-tech enterprises and economically developed regions. Chen and Hao (2022) further extended the exploration of digital transformation, investigating its relationship with environmental performance from the perspective of board characteristics. The study highlighted the moderating effect of board characteristics on the impact of digital transformation,

emphasizing the preferences for digital transformation strategies in boards with more female directors and higher educational backgrounds. Niu et al. (2023) delved into the impact of digital transformation on capital structure adjustment speed, demonstrating its role in accelerating adjustments and improving the likelihood of leverage adjustment. This finding complements an exploration of the impact of digital transformation on performance by Zhai et al. (2022), which quantified the extent of digital transformation and documented its long-term benefits and short-term impacts.

Based on dynamic capability theory, corporate digital transformation can enhance companies' ability to adopt trade credit in the following ways. First, digital transformation has become a way for companies to gain competitive advantages (Ferreira et al., 2019). Firms with a high competitive advantage have more bargaining power than those with a low competitive advantage, and they are taking advantage of their bargaining power to get more favorable terms, forcing suppliers to make more concessions in terms of price, delivery time, and product quality, and the more trade credit they ask for from suppliers (Fabbri & Klapper, 2016). In addition, these firms have the ability to allow customers to purchase goods or services on credit, that is, provide trade credit. Second, using digital technology can be improved business processes, making the transmission of information within the enterprise smoother, so that senior management can obtain information about the business activities, investment activities, and financing activities in a timely manner, thus optimizing the allocation of funds and obtaining or providing trade credit in a reasonable manner. Third, digital transformation improves the quality of internal controls (Jiang et al., 2022). Higher quality internal control enables suppliers to have more reliable information about the actual financial situation of the company, which promotes the formation of trust relationships between upstream and downstream companies and reduces transaction costs. Moreover, managers coordinate activities between various inputs and participate in corporate decision-making (Fama, 1980), which can directly interfere with the magnitude of trade credit through corporate digital transformation embedded in different managerial ability. Therefore,

1. *Do corporate digital transformation affect all directions of trade credit (received and provided)?*
2. *How do managerial ability affect the relationship between trade credit and corporate digital transformation?*

Consequently, we empirically study 10,554 observations of 2509 A-share listed firms in a Chinese context to verify how corporate digital transformation affects trade credit. The study found that trade credit has increased as a result of corporate digital transformation, both from a demand-side and supply-side perspective. Based on this, this study further explores the role of managerial ability in the corporate digital transformation and trade credit nexus, contributing the most recent papers on managerial ability (Baghdadi et al., 2023; Khoo & Cheung, 2022). Specifically, we find that the positive relationship between digital transformation and trade credit is strengthened when managers have a financial background or firms are smaller in size. Our results are robust under the battery of tests used, such as propensity score matching, Heckman two-step regression, substitution of independent variable measures, and lagged independent and control variables.

This study extends the existing literature on trade credit management from the digital transformation perspective. First, in contrast to previous research that concerned the consequences of digital transformation on product competitive advantage (Blichfeldt & Faullant, 2021), corporate financial performance (Abou-foul et al., 2021), and customer value creation (Matarazzo et al., 2021), our research examines the impact of corporate digital transformation on the scale of trade credit. In addition, we discuss the variation of this effect in a variety of contexts, such as managerial ability, financial background, and firm size. Moreover, this research delves into the impact of digital transformation on both the reception and provision of trade credit, contributing to Burkart and Ellingsen (2004), Box et al. (2018), among others. The contract-theoretic model of Burkart and Ellingsen (2004) elucidates the factors influencing the liberal lending behavior of suppliers in comparison to banks, providing explanations for phenomena such as short trade credit maturity and its prevalence in less developed credit markets. Box et al. (2018) investigated the positive relationship between trade credit extension and future profitability, suggesting that aggressive trade credit policies could serve as a unique channel for improving product market performance. In this paper, although we do not explicitly examine the interactions between the reception and provision of trade credit, we do report the impact of digital transformation on

both aspects. This contributes to the existing literature, which has predominantly focused on trade credit from either the receiver's perspective (Cao et al., 2022; Ge & Qiu, 2007; Kong et al., 2020) or solely from the provider's viewpoint (Fabbri & Klapper, 2016; Liu & Wang, 2023). Our study, by considering both dimensions, enhances the understanding of the implications of digital transformation on the dynamics of trade credit. This study actively responds to the call for different directions of research on trade credit from Astvansh and Jindal (2022).

Finally, from the research data standpoint, a Chinese dictionary of digital transformation was built based on policy documents and existing studies using text analysis, and then calculated the frequencies of these keywords in the annual financial reports of listed firms as a proxy variable for corporate digital transformation. Our study contributes to and extends recent papers that have employed textual analysis, such as Chen et al. (2022), Chen and Hao (2022), Wu et al. (2022a), Zhai et al. (2022), among others. It provides novel evidence on the moderating role of managerial ability in the nexus between digital transformation and trade credit.

Our study proceeds as follows. Section 2 provides a conceptual background and discusses previous literature following Andersson et al. (2014) framework. Section 3 presents the data, variables, and methods. The empirical results of this study and robustness of the findings are discussed in Section 4. Section 5 summarizes our findings, possible limitations, and future research directions.

2 | THEORY AND HYPOTHESES DEVELOPMENT

2.1 | Corporate digital transformation

There is no consistent definition of digital transformation in the existing studies. For example, Verhoef et al. (2021) consider that digital transformation requires specific organizational structures and has an impact on the metrics used to calibrate performance. Considering that digital technologies empower companies to carry out digital transformation, which in turn enhances their ability to use business credit. Vial (2019) argues that digital transformation causes significant changes in the properties of entities to improve them, and that this process requires a combination of information, computing, communication, and connectivity technologies. Warner and Wager (2019) defined digital transformation as the process of using digital technologies like mobile, artificial intelligence, cloud, blockchain, and IoT to realize significant business improvements and create new business models. In our paper, the description of digital transformation by Warner and Wager (2019) is used. We believe this description comprehensively encompasses the variety of technologies that are transforming both society and business. This perspective aligns more closely with the understanding of digital transformation presented in the finance literature.

There are three main areas of existing research on corporate digital transformation. First, digital transformation is tightly linked to digital strategy. In the digital era, in which digital technologies have a profound impact on business and management, digital transformation changes the corporate strategy for value creation (Menz et al., 2021), requiring companies to apply digital strategies to better advance the process of digital transformation. Digital strategy development should determine the components of companies' business models that must be revised in line with the new strategy. Correani et al. (2020) structured a framework for encouraging firms to undertake digital transformation of their business, which helps firms to address challenges related to implementing digital strategies and ensure that any key elements that constitute the strategy are not overlooked when senior managers are involved in digital strategy implementation. Canhoto et al. (2021) identify a sample of five industries for the digital aligning model, grounded in practice, to provide a theoretical basis for how small and medium-sized enterprises (SMEs) can effectively implement digital strategies.

Second, digital transformation requires companies to have the appropriate digital competencies. The ability to move to a more advanced stage of digital transformation is associated with managerial characteristics with a more democratic leadership style, more consistent managerial action on the company's mission, and more effective strategic management processes to facilitate the progress of digital transformation (Porfírio et al., 2021). Firk et al. (2021) argue

that it is necessary for companies to appoint a chief digital officer because digital transformation is related to corporate strategy, and companies need people with more expertise to deal with the challenges of the strategic shift. In addition, Scuotto et al. (2021) assert that the ability of SMEs to innovate depends on employees with the right digital competencies and that individual digital competencies are seen as an important key asset that enables companies to take advantage of new opportunities to increase efficiency and discover new ways to create and manage their business. In addition, the utilization of digital technologies empowers firms to access, in a timely manner, information related to business activities, such as contacting potential customers before demand arises (Matarazzo et al., 2021), improving the dynamic capabilities of firms and, in turn, influencing incremental and radical innovation capabilities, creating value and improving performance.

Third, we study the effects of digital transformation using firm-level characteristics. Adoption of digital technologies not only creates new business opportunities and managerial advantages (Scuotto et al., 2021) but also improves communication with customers, which leads to a greater comprehension of requirements and facilitates the production of customized and new products tailored to specific customer needs (Matarazzo et al., 2021). Furthermore, digital transformation significantly reduces the cost of opacity and improves the quality of internal controls, which in turn reduces the risk of share price collapse (Jiang et al., 2022). Urbinati et al. (2020) show that digital technology can amplify the innovation capacity of firms, while Usai et al. (2021) state that innovation is the result of creativity and continuous research and development (R&D) efforts and that overutilization of digital technology may even deplete the long-term creative capacity of firms.

2.2 | Determinants of trade credit

Existing studies on the determining factors of trade credit adoption by firms can be divided into macro- and micro-levels. At the macro level, there is a wide use of trade credit by medium, small, and micro firms in the financial crisis (Carbó-Valverde et al., 2016). The view of Love et al. (2007) is that the availability of trade credit may increase after the financial crisis but contract in the following period. D'Mello and Toscano (2020) state that in periods of increased economic uncertainty, corporate accounts receivable and accounts payable ratios decline. Excessive trade credit tightening in times of high policy uncertainty may drive customers to competitors, resulting in a decline in company value (Jory et al., 2020).

At the micro level, firms' characteristics have a non-negligible impact on whether they participate in trade credit. Hasan and Habib (2019), using US data from 1997 to 2015, show that social capital, directly and indirectly, affects firms' acquisition of trade credit, which is used less by firms headquartered in areas with high social capital. Using data from China, Kong et al. (2020) demonstrate that the hometown of the CEO's connection to the supplier significantly increases access to trade credit via information as well as social trust channels. Chen et al. (2021) stand for the financing advantage perspective of state ownership and confirm the positive link between state ownership level and trade credit provision. By contrast, non-state firms prefer to accept trade credit in order to meet their financing needs (Ge & Qiu, 2007). Higher socially performing companies are better able to obtain trade credit because suppliers consider their customers' corporate social responsibility activities as a sign of trustworthiness and ability to fulfil their financial commitments (Zhang et al., 2020). Additionally, suppliers are more inclined to extend trade credit to powerful and important customers and to firms with strong bargaining power (Fabbri & Klapper, 2016; Mateut & Chevapatrakul, 2018).

2.3 | Corporate digital transformation as a new source of trade credit

Digitalization affects all aspects of a microenterprise and can have a significant impact on business operations, investments, and financing activities. The use of digital technologies also helps firms to adapt to changing environmental

conditions (Vial, 2019). Trade credit, as one of the ways of external financing, is a strategic channel for companies to obtain operating funds and has various impacts on their management and development (Pike et al., 2005). Therefore, in the context of the digital era, exploring how digital transformation relates to trade credit is important.

First, digital transformation has become a part of strategy for most Chinese companies to digitize their business using digital technology. Digital processes are built to connect business operations and management and achieve both efficiency and effectiveness, enabling firms to cultivate new business models and core competencies under the new digital business environment, thereby increasing their competitive advantage and market power (Verhoef et al., 2021; Zhu et al., 2015). High-market power companies have more bargaining power in their supply chains and can request more trade credit or preferential and delayed payment terms (Lee et al., 2018). As a result of their increased market power, they may be better positioned to extend trade credit due to their greater ability to enforce contracts, assess customer credit risk and offer more flexible credit terms (Martinez-Sola et al., 2014). Moreover, the use of digital technology has changed the competitive landscape of the market (Verhoef et al., 2021). In the face of highly competitive market conditions, firms use trade credit as a competitive tool (Fabbri & Klapper, 2016) and offer commercial credit and better credit terms. At this point, trade credit becomes larger.

Second, firms use digital technology to analyze the massive amount of data generated from daily business activities, and such data analyses can be used to solve management problems (Wu et al., 2019) and meet managers' needs for timely and accurate information, which in turn improves the quality of internal control (Jiang et al., 2022). The core and primary objective of internal control is to guarantee the quality of corporate financial reporting, and the debt-paying ability, profitability, and assets available for collateral reflected in the financial statements of trade credit applicants are the important elements of the "5C" credit evaluation system adopted by upstream suppliers, namely, character, capacity, capital, collateral, and conditions. The financial statement information, in other words, is particularly important for contracts (Costello & Wittenberg-Moerman, 2011). The accounting performance of the company is taken into account by suppliers and customers when assessing whether the company can satisfy its short-term trade obligations (Hui et al., 2012). Trade credit involves two aspects of the balance sheet: accounts payable as a representation of received trade credit, that is, liability side, and accounts receivable as a representation of provided trade credit, that is, asset side (Petersen & Rajan, 1997). High-quality financial reports provide the necessary information for debt covenant signing and execution, and truthful and robust financial accounting information facilitates suppliers' trust decisions on whether to grant trade credit. As the quality of internal controls increases, the less likely that cash holdings will be abnormal (Chen et al., 2020), which helps to improve a firm's solvency and reduce creditors' and investors' risk expectations, when the firm's willingness to receive and provide trade credit is also stronger.

2.4 | The moderating role of managerial ability

Managerial ability is the efficiency with which managers convert firm resources into revenue in comparison to their peers in their industry (Demerjian et al., 2012). The upper echelons theory of Hambrick and Mason (1984) explains that managerial traits influence strategic choices, which influence firm behavior. For example, Bertrand and Schoar (2003) find that fixed managerial effects have a broad impact on firms' decisions by constructing a panel dataset of manager-firm matches, arguing that managerial fixed effects differ significantly in terms of firm investment and financial and organizational policies. Prior studies show that high-ability managers have a huge economic impact on business decisions and performance (Andreou et al., 2017), the use of short-term debt (Shang, 2021), risk-taking (Andreou et al., 2016), derivatives use for risk management(Cheng & Cheung, 2021), and real growth option (Driouchi et al., 2022). Focused on our research topic, Khoo and Cheung (2022) discovered that companies with higher managerial ability are inclined to increase received trade credit, especially in situations of poor credit quality or significant financial constraints. However, our study does not discuss the direct/indirect impact of managerial ability on digital transformation or trade credit, but focuses on whether the impact of digital transformation on trade credit will change under different managerial ability scenarios based on the upper echelons theory.

On the one hand, the environment of trust created by high-capacity managers creates the conditions for digital transformation to take an active role. Demerjian et al. (2013) claim that competent managers better understand their business, technology, and industry trends. Managerial ability gives firms the skills or tools to adapt to and learn from uncertainty (Driouchi et al., 2022). More capable managers reduce default risk by reducing the probability of firms defaulting on principal and interest payments (Bonsall et al., 2017), identifying value-creating investments, along with their performance in optimizing capital structure and responding to external shocks (Cornaggia et al., 2017). Thus, capable managers often demonstrate pragmatism and foresight in business decision-making, emphasizing the development of various formal and informal systems, including the establishment of a culture of trust. Highly competent managers can achieve better firm performance by choosing better projects and implementing them more effectively, as well as by providing more reliable financial reports or using other signals to build credibility (De Franco et al., 2017). Being based on trust can lead to the establishment of contractual relationships between firms and their suppliers or customers, detailing the terms and conditions of purchases or sales on credit and providing a framework for the use of trade credit. High managerial ability hence plays an important role in establishing a trustworthy environment to drive digital transformation in the use of trade credit. We further ruled out the potential reverse interaction in which trade credit moderates the relationship between digital transformation and managerial ability, due to the absence of theoretical arguments that could explain this effect.

On the other hand, high managerial ability can increase corporate transparency to pave the way for greater role in digital transformation. Incompetent managers are more likely to face operational crises, so they need to issue positive or even untrue statements through informal channels to cover up bad news about the company. In contrast, financial statements overseen by highly competent managers are characterized by fewer subsequent restatements and higher surplus persistence (Demerjian et al., 2013). High-capacity managers tend to improve the quality of information disclosure through required disclosure or informal channels to boost corporate transparency (Wu et al., 2022b), a more efficient and fair capital market information environment will be established. In the process of information transmission, firms can dynamically adjust their credit policies to meet their partners' business needs to adjust credit policies, enhance cooperation, and promote the usage of trade credit.

According to the aforementioned analysis, the role of managerial ability as a moderator in the impact of digital transformation on trade credit is pivotal. Drawing from the upper echelons theory, managerial traits significantly influence strategic choices and subsequently shape firm behavior. Highly competent managers with profound understanding of business dynamics, technology, and industry trends create a market environment of trust and transparency. In such contexts, the probability that firms undertaking digital transformation activities will take advantage of trade credit increases (as illustrated in Figure 1). Accordingly, this research proposes the following hypotheses:

H1: *Managerial ability positively moderates the relationship between digital transformation and received trade credit.*
H2: *Managerial ability positively moderates the relationship between digital transformation and provided trade credit.*

3 | METHODOLOGY

3.1 | Sample selection

The sample includes 2509 A-share listed companies from 2014 to 2020. We exclude firms in the financial sector because they are regulated differently and firms that have been given special treatment due to unusual financial conditions. The China Stock Market and Accounting Research (CSMAR) database was used to obtain firm-level financial data. The annual reports of all listed companies are obtained from the Juchao website (http://www.cninfo.com.cn). To control for interference from extreme values, all continuous controls and dependent variables are winsorized at the 1% level. The final sample includes 10,554 firm-year observations from 2509 listed companies.

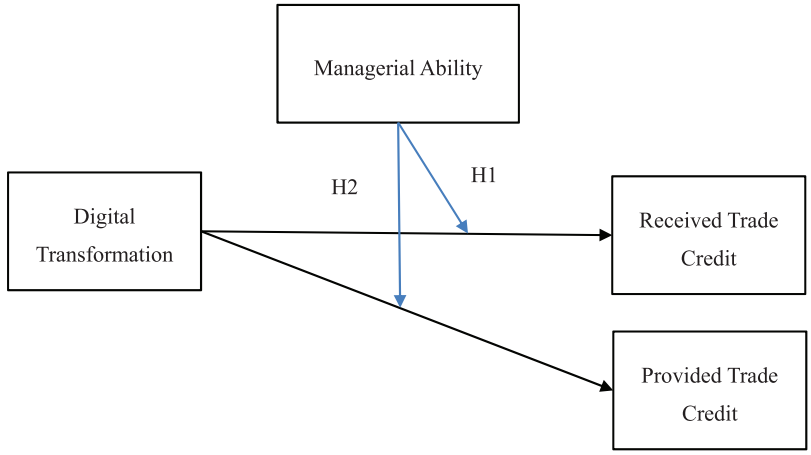

FIGURE 1 Research design.

3.2 | Measures

3.2.1 | Trade credit

We focus on two major variables, accounts payable and accounts receivable, which represent the trade credit that firms receive from suppliers and provide to customers, respectively (Love et al., 2007). We use the ratio of accounts payable to total assets as a proxy variable for received trade credit and the ratio of accounts receivable to total assets as a proxy variable for provided trade credit based on previous research (Ge & Qiu, 2007; Martinez-Sola et al., 2014; Mateut & Chevapatrakul, 2018; Wu et al., 2021).

3.2.2 | Corporate digital transformation

Annual reports of the listed firms are regular forms of corporate disclosure. Disclosures include, but are not limited to, business operations, and the information disclosed in annual reports is considered highly credible (Unerman, 2000). Moreover, digital transformation, as a business strategy implemented by companies during the digital wave (Correani et al., 2020), is reflected in corporate annual reports. As a result, measuring the extent of transformation of listed firms based on the frequency of terms related to "*corporate digital transformation*" in their annual reports is both feasible and scientific. In addition, Buehlmaier and Whited (2018) construct a measure of financial constraint indicators through textual analysis of annual company reports, which provides an illuminating analogous logic for this study.

In this study, we collect annual reports from A-share listed firms using a Python crawler and extract all text content using Adobe Acrobat. Regarding the keyword identification of corporate digital transformation, this study discusses from both academic literature and policy documents. In the academic literature, Vial (2019) reports that existing digital technologies include technologies related to social, mobile, analytics, cloud, IoT, the Internet, software, and blockchain. In addition to blockchain and IoT, Verhoef et al. (2021) claim that emerging digital technologies also include artificial intelligence and robotics. Warner and Wager (2019), in defining digital transformation, mention that digital technologies include mobile, artificial intelligence, cloud, blockchain, and IoT technologies. Based on these studies, we identify five dimensions of digital transformation for inclusion in our study. Furthermore, the important policy documents, the "Special Action Plan for Digital Empowerment of SMEs" and the "Notice on Accelerating the Digital Transformation of State-owned Enterprises", are used as blueprints to expand the terms. Table 1 lists the expanded keywords of digital transformation.

TABLE 1 Keywords of corporate digital transformation.

Dimension	Characteristic words
Artificial intelligence technology	人工智能、智能、智能化、人脸识别、自然语言、图像识别、人机交互、无人驾驶、机器人、计算机辅助、神经网络
	artificial intelligence, intelligence, intelligent, face recognition, natural language, image recognition, human-computer interaction, driverless, robotics, computer-aided, neural network
Blockchain technology	区块链、分布式计算
	blockchain, distributed computing
Cloud computing technology	云计算、云化、信息、信息化、线上、互联网、物联网、网络化、网上、网络平台
	cloud computing, clouding, information, informatization, online, internet, internet of things, networking, online, network platform
Big data technology	数据、大数据、数据中心、数据安全、数据分析、数据共享、数据管理、数据服务、数据处理、数据挖掘、数据交换、虚拟现实、虚拟、虚拟化、数字化、可视化
	data, big data, data center, data security, data analysis, data sharing, data management, data services, data processing, data mining, data exchange, virtual reality, virtual, virtualization, digitization, visualization
Digital technology application	数字技术、数字化转型、数字孪生、信息技术、信息系统、信息网络、信息管理、管理信息系统、金融科技、互联网金融、智慧、智慧城市、智慧农业、智慧能源、智慧物流、智慧化、智能工厂、智能家居、智能网联、智能仪表、智能交通
	digital technology, digital transformation, digital twin, information technology, information system, information network, information management, management information system, financial technology, internet finance, smart, smart city, smart agriculture, smart energy, smart logistics, smartening, intelligent factory, intelligent home, intelligent network connection, intelligent meter, intelligent transportation

Finally, the frequency of keywords is used to calculate the degree of digital transformation of corporates. As this type of data is typically prone to "right bias" characteristics, and there may be listed firms that have not carried out digital transformation, this research adds 1 to the word frequencies. Logarithmic processing is performed to obtain the overall indicators of digital transformation.

3.2.3 | Managerial ability

We use the following calculation as a proxy variable for managerial ability, based on Demerjian et al. (2012) and Wu et al. (2022b). In the first step, these researchers use data envelopment analysis (DEA) to estimate firm efficiency within its industry, with operating revenue (Sales) as the output variable. There are also six input variables: operating costs (*CoGS*), selling and administrative expenses (*SG&A*), net fixed assets (*PPE*), intangible assets (*Intangible*), goodwill (*Goodwill*), and R&D expenses (*R&D*). Thus, the following problem is solved using DEA, as specified in Equation (1):

$$\max_v \theta = \frac{Sales}{v_1 GoGS + v_2 SG\&A + v_3 PPE + v_4 In\tan gible + v_5 Goodwill + v_6 R\&D} \quad (1)$$

DEA generates an efficiency indicator θ with a value ranging from 0 to 1. This value is influenced by both the firm and managerial ability. As a result, the second step is to separate the role of managerial ability using Tobit regression.

TABLE 2 Main variable definitions.

Code	Definition
RTC	Received trade credit, measured by accounts payable/total assets
PTC	Provided trade credit, calculated as the ratio of accounts receivable to total assets
DT	Natural logarithm of the number of keyword disclosures (plus 1) for corporate digital transformation.
MA	Managerial ability, measured by the DEA-Tobit method
SIZE	Firm size, calculated as the natural log of total assets
LEV	Financial leverage, calculated as total debt divided by total assets
GROWTH	Sales growth, computed as the increase in operating income over the previous year divided by operating income from the previous year
MTB	Market-to-book ratio, ratio of the market value of equity to the book value of equity
ROA	Return on assets, the net profit divided by the total assets
R&D	Ratio of R&D to sales
TANG	The ratio of fixed assets to total assets
CASH	Cash flow, the ratio of net cash flow from operations to total assets
TOP1	The stake of the largest shareholder, the percentage of shares held by the largest shareholder
SOE	Indicator of the nature of ownership, with firms that are state-owned assigned a value of one and others assigned a value of zero
YEAR	Dummy variable of firms' year
IND	Dummy variable. Industry classification is based on that of the China Securities Regulatory Commission (CSRC), which recognizes 21 industries, with a one-digit code for non-manufacturing industries and a two-digit code for manufacturing industries

Equation (2) represents the regression model.

$$Firm\ Efficiency = a_1 + a_2 \ln(AT) + a_3 MS + a_4 FCF + a_5 Age + a_6 BHHI + a_7 FC + Year + \varepsilon \quad (2)$$

The residual of Equation (2) is managerial ability, with variables winsorized at the extreme 1% level. The variables are described below. Model (1) is used to assess firm efficiency. *AT* denotes total assets. Market share (*MS*) is the firm's share of operating revenues in its industry. When a company has non-negative free cash flow, *FCF* is coded as 1. The natural logarithm of the number of years the firm has been listed is used to calculate *Age*. The business complexity of the firm is represented by *BHHI*, which is the ratio of revenue from main operations to total revenue. If the firm has revenue from overseas operations, *FC* is 1, otherwise it is 0.

3.2.4 | Control variables

Based on prior studies (D'Mello & Toscano, 2020; Wu et al., 2021), we include the control variables of *SIZE*, *LEV*, *GROWTH*, *MTB*, *ROA*, *R&D*, *TANG*, *CASH*, *TOP1*, and *SOE*. The model includes year and industry dummy variables to account for time-invariant industry heterogeneity and time trends. The definition of the main variables is shown in Table 2.

TABLE 3 Descriptive statistics.

Variables	N	Mean	p50	SD	Min	Max
RTC	10554	0.0955	0.0792	0.0676	0.0054	0.3296
PTC	10554	0.1434	0.1266	0.1030	0.0017	0.4837
DT	10554	4.7828	4.6821	0.7197	0.0000	7.5601
SIZE	10554	22.3195	22.1693	1.1287	20.2248	25.7092
LEV	10554	0.4160	0.4067	0.1894	0.0688	0.8654
GROWTH	10554	0.1787	0.1133	0.3897	−0.4887	2.3301
MTB	10554	3.9993	3.3017	2.5079	1.3343	16.1410
ROA	10554	0.0392	0.0394	0.0679	−0.2737	0.2119
RD	10554	4.9331	3.7400	4.8413	0.0300	27.2900
TANG	10554	0.1941	0.1692	0.1358	0.0034	0.6126
CASH	10554	0.0497	0.0475	0.0616	−0.1216	0.2297
TOP1	10554	32.1983	30.0900	14.0016	8.0900	70.6400

Note: (1) the ratio of accounts receivable to total assets is 14.34% on average, which is consistent with statistics provided by Wu et al. (2012). (2) The mean value of digital transformation is greater than the median value, indicating that the distribution of digital transformation is somewhat right-skewed.

3.3 | Regression models

After controlling for year and industry effects, ordinary least squares (OLS) was used to test the relationship between corporate digital transformation and trade credit. The principal coefficient of interest is β_1 in Equation (3), which is expected to be positive.

$$RTC_{i,t}/PTC_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \sum_{k=2}^{12} \beta_k CV_{i,t} + YearFixedEffect_t + IndFixedEffect_i + \varepsilon_{i,t} \quad (3)$$

To test the moderating effect of managerial ability (H1 and H2), the following OLS regression model is used. The principal coefficient of interest is β_3, and its significance and sign are examined.

$$\begin{aligned} RTC_{i,t}/PTC_{i,t} = {} & \beta_0 + \beta_1 DT_{i,t} + \beta_2 MA_{i,t} + \beta_3 DT_{i,t} * MA_{i,t} \\ & + \sum \beta_k CV_{i,t} + YearFixedEffect_t + IndFixedEffect_i + \varepsilon_{i,t} \end{aligned} \quad (4)$$

In the Equation (3) and (4), *CV* represents all control variables. To address potential heteroscedasticity issues, we determine heteroscedasticity-robust standard errors in the regression model using robust standard errors clustered at the firm level.

4 | RESULTS

4.1 | Descriptive statistics

Table 3 shows the descriptive statistics for the variables mentioned above. Accounts payable account for 9.55% of total assets on average, while accounts receivable account for 14.34% of total assets on average, which is basically consistent with Wu et al. (2012). The mean value of digital transformation (*DT*) is higher than the median value of

4.6821, indicating that the distribution of digital transformation is skewed to the right. In terms of control variables, the mean of *ROA* is 0.0392, indicating that listed firm' profitability needs to be improved further; the mean of *GROWTH* is 0.1787, indicating that listed firm' growth is good; and the mean of *TOP1* is 32.1983, indicating that the shareholding ratio of the first largest shareholder of listed companies is high.

4.2 | Regression results

All regressions in Table 4 account for fixed effects such as year and industry. In column (1), there is a significant positive effect of *DT* on *RTC* ($\beta_1 = 0.0068$, $p < 0.01$), indicating that as the extent of corporate digital transformation increases, the ability of firms to access trade credit also increases. The coefficient between *DT* and *PTC* in column (2) is significantly positive ($\beta_1 = 0.0202$, $p < 0.01$). That is, as digital transformation increases, firms' willingness to extend trade credit to their customers expands.

The interaction term $DT \times MA$ is positive and significant ($\beta_3 = 0.0146$, $p < 0.01$) in Column (3), indicating that managerial ability moderates the relationship between digital transformation and received trade credit. Therefore, H1 is verified. Column (4) demonstrates that the interaction term $DT \times MA$ is not significant ($\beta_3 = 0.0074$, $p > 0.1$), indicating that there is no moderating effect in the relationship between managerial ability and provided trade credit; thus, H2 is not verified. The reason for this phenomenon may be that the large presence of trade credit stems from the buyer's strength (Fisman & Raturi, 2004) and the provision of trade credit to customers is also used as a competitive tool (Fabbri & Klapper, 2016). Conversely, customers may appear less assertive when dealing with companies with high managerial ability. In addition, companies with high managerial ability can gain a greater competitive advantage by judging external industrial trends and allocating their own resources effectively. In this context, there may be a certain degree of reduction in the use of competitive tools, such as providing trade credit to customers; after all, there is a risk that accounts receivable will not be collected on time, thus increasing the risk of bad debts.

4.3 | Robustness tests

4.3.1 | Propensity score matching

To address potential reverse causality as well as self-selection bias, we used propensity score matching. First, the sample is grouped into two samples according to the year-industry corporate digital level, and the corporate digital transformation dummy variable is set. The level of corporate digital transformation is higher than the year-industry median taken as 1, indicating that the company has a high extent of digital transformation; otherwise, it has a value of 0. The logit model is then used to calculate the propensity score for each observation sample, where the explanatory variables are the enterprise dummy variables for digital transformation and the explanatory variables are all control variables used in this study. To minimize the effect of sample selection bias, the scores are matched using 1:1 nearest neighbor matching and kernel matching. Finally, the correlation regression analysis is re-run using the matched samples. Tables 5 and 6 show the sample regression analysis results after propensity score matching, with received and provided trade credit used as an explanatory variable, respectively. For both received and provided trade credits results show statistically positive and significant impact of digital transformation, however, the interaction term between managerial ability and digital transformation is significant only for received trade credit. This consistent with the results reported in Table 4, suggesting rejection of H2 and acceptance of H1.

TABLE 4 Impact of corporate digital transformation on credit and the moderating effect of managerial ability on that relationship using ordinary least squares analysis.

	(1)	(2)	(3)	(4)
Variables	**RTC**	**PTC**	**RTC**	**PTC**
DT	0.0068***	0.0202***	0.0074***	0.0207***
	(6.5513)	(11.8475)	(7.0273)	(12.1069)
MA			−0.0426**	−0.0020
			(−2.5283)	(−0.0679)
DT × MA			0.0146***	0.0074
			(4.0730)	(1.1736)
SIZE	−0.0051***	−0.0272***	−0.0040***	−0.0258***
	(−7.9634)	(−27.5588)	(−6.2287)	(−25.8135)
LEV	0.1682***	0.1653***	0.1642***	0.1602***
	(37.9815)	(23.7037)	(37.1672)	(22.9570)
GROWTH	−0.0011	−0.0050**	−0.0021	−0.0060**
	(−0.7112)	(−2.0929)	(−1.2967)	(−2.5285)
MTB	−0.0003	−0.0028***	−0.0002	−0.0027***
	(−0.8574)	(−6.0005)	(−0.6465)	(−5.8409)
ROA	0.0405***	0.1520***	0.0257**	0.1346***
	(3.8375)	(8.4517)	(2.4369)	(7.4655)
RD	−0.0016***	−0.0015***	−0.0013***	−0.0011***
	(−13.4414)	(−6.8402)	(−9.9642)	(−4.7270)
TANG	−0.0440***	−0.1735***	−0.0418***	−0.1704***
	(−9.0807)	(−24.3065)	(−8.6102)	(−23.8190)
CASH	0.0443***	−0.2005***	0.0390***	−0.2086***
	(4.1223)	(−11.4216)	(3.6212)	(−11.8031)
TOP1	0.0003***	−0.0002***	0.0003***	−0.0002***
	(7.1742)	(−2.6519)	(7.2538)	(−2.5785)
Constant	0.0779***	0.5631***	0.0502***	0.5302***
	(5.4882)	(25.5480)	(3.5250)	(23.6088)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	10554	10554	10554	10554
Adj R^2	0.3936	0.3171	0.3989	0.3203

Note: From the Columns (1) and (2), digital transformation significantly increases the trade credit from both received and provided. The interaction term DT × MA is positive and significant in Column (3), but the interaction term DT × MA is not significant in Columns (4), therefore, H1 is supported but H2 is not supported. *, **, and *** indicate the significance levels of 10%, 5%, and 1%, respectively.

TABLE 5 Propensity score matching: received trade credit.

	RTC			
	1:1 nearest neighbour matching		kernel matching	
Variables	(1)	(2)	(3)	(4)
DT	0.0074***	0.0080***	0.0068***	0.0074***
	(4.9571)	(5.3291)	(6.5675)	(7.0452)
MA		−0.0279		−0.0425**
		(−1.0764)		(−2.5205)
DT × MA		0.0125**		0.0146***
		(2.2691)		(4.0677)
SIZE	−0.0051***	−0.0038***	−0.0051***	−0.0040***
	(−5.5664)	(−4.0528)	(−7.9808)	(−6.2499)
LEV	0.1687***	0.1639***	0.1682***	0.1642***
	(26.8699)	(26.0980)	(37.9727)	(37.1603)
GROWTH	0.0005	−0.0003	−0.0012	−0.0021
	(0.2178)	(−0.1207)	(−0.7527)	(−1.3398)
MTB	0.0001	0.0001	−0.0003	−0.0002
	(0.1137)	(0.3043)	(−0.8494)	(−0.6373)
ROA	0.0233	0.0065	0.0406***	0.0258**
	(1.5635)	(0.4399)	(3.8500)	(2.4492)
RD	−0.0017***	−0.0013***	−0.0016***	−0.0013***
	(−10.1875)	(−7.6093)	(−13.4669)	(−10.0011)
TANG	−0.0435***	−0.0402***	−0.0440***	−0.0418***
	(−6.3811)	(−5.8765)	(−9.0741)	(−8.6087)
CASH	0.0576***	0.0507***	0.0443***	0.0390***
	(3.8276)	(3.3732)	(4.1218)	(3.6203)
TOP1	0.0003***	0.0003***	0.0003***	0.0003***
	(4.6356)	(4.5859)	(7.1685)	(7.2466)
Constant	0.0734***	0.0400*	0.0781***	0.0505***
	(3.5176)	(1.9002)	(5.5031)	(3.5429)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	5335	5335	10550	10550
Adj R^2	0.4128	0.4192	0.3935	0.3989

Note: The regression coefficients of digital transformation are significantly positive at the 1% level for both 1:1 nearest neighbour matching and kernel matching, and the regression coefficients of the interaction term between managerial ability and digital transformation are significantly positive at the 1% level, which are highly consistent with those in Table 4. *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

TABLE 6 Propensity score matching: provided trade credit.

	PTC			
	1:1 nearest neighbour matching		kernel matching	
Variables	(1)	(2)	(3)	(4)
DT	0.0225***	0.0231***	0.0201***	0.0207***
	(9.5106)	(9.7122)	(11.8230)	(12.0842)
MA		−0.0051		−0.0024
		(−0.1218)		(−0.0806)
DT × MA		0.0081		0.0075
		(0.9018)		(1.1839)
SIZE	−0.0273***	−0.0259***	−0.0271***	−0.0258***
	(−19.1921)	(−17.8201)	(−27.5151)	(−25.7790)
LEV	0.1676***	0.1624***	0.1653***	0.1603***
	(16.7496)	(16.2502)	(23.6997)	(22.9563)
GROWTH	−0.0030	−0.0039	−0.0049**	−0.0059**
	(−0.8540)	(−1.0937)	(−2.0309)	(−2.4678)
MTB	−0.0020***	−0.0019***	−0.0028***	−0.0027***
	(−2.9152)	(−2.8068)	(−6.0111)	(−5.8509)
ROA	0.1506***	0.1333***	0.1517***	0.1344***
	(6.0166)	(5.3178)	(8.4348)	(7.4512)
RD	−0.0019***	−0.0015***	−0.0015***	−0.0011***
	(−5.9526)	(−4.4258)	(−6.7616)	(−4.6603)
TANG	−0.1739***	−0.1701***	−0.1735***	−0.1704***
	(−16.7948)	(−16.2864)	(−24.2781)	(−23.7958)
CASH	−0.1958***	−0.2036***	−0.2005***	−0.2085***
	(−7.8342)	(−8.1089)	(−11.4201)	(−11.7998)
TOP1	−0.0001	−0.0001	−0.0002***	−0.0002**
	(−1.5928)	(−1.6336)	(−2.6474)	(−2.5756)
Constant	0.5471***	0.5119***	0.5626***	0.5298***
	(17.0910)	(15.6506)	(25.5142)	(23.5848)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	5335	5335	10550	10550
Adj R^2	0.3190	0.3219	0.3170	0.3202

Note: The regression coefficients of digital transformation are significantly positive at the 1% level for both 1:1 nearest neighbour matching and kernel matching, while the coefficient of the interaction term between manager ability and digital transformation is not significant, which are basically consistent with those in Table 4.*, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

4.3.2 | Heckman two-stage regression model

To address potential sample selection bias, we utilize a Heckman two-stage regression model. In the first stage, a probit regression model includes the digital transformation dummy variable and the place of registration (*PRO*) as an exogenous instrumental variable. The inverse Mills ratio (*IMR*) is then calculated post-regression, controlling for various variables. *PRO* is 1 if the enterprise registered in the economically developed regions in Eastern China, such as Hebei, Beijing, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong and Hainan, and 0 otherwise. These regions, characterized by advanced economic development, serve as a crucial exogenous variable influencing corporate digital transformation due to their solid economic foundation, advanced development path, and well-established infrastructure. The location of registration emerges as a significant exogenous factor influencing corporate digital transformation.

The Heckman two-stage regression robustness test results are shown in Table 7. The probit regression results in the first stage show that the coefficient of the place of registration is significantly positive, noting that the location of the enterprise drives the digital transformation process. In Stage 2, the results show that the *IMR* is significant, indicating the existence of the self-selection problem. By introducing *IMR* as a control variable into the original regression model for re-regression, the results support the theoretical expectations of H1, but not H2, indicating that the findings still hold after accounting for the endogeneity problem caused by sample selection bias.

4.3.3 | Different corporate digital transformation variable

To make our findings more convincing, we rerun the regressions directly using data from the CSMAR database, which is authoritative, professional, as well as accurate, and can comprehensively cover the semantic characteristics of digital transformation, although it only provides a smaller sample of 379 firms. The regression results are presented in Table 8, and these are consistent with previous findings suggesting rejection of hypotheses H2.

4.3.4 | Lagged explanatory variables and control variables

To address the endogeneity issue caused by simultaneity, we repeated the digital transformation after a one-period lag, as previously done by Chen et al. (2019) and Jiang et al. (2022). Table 9 shows the results, which are similar to the main findings reported in Table 4. As a result, we can continue to conclude that digital transformation empowers the use of trade credit.

4.4 | Heterogeneity concerns

4.4.1 | Financial background

This section further examines whether executives with financial backgrounds influence the relationship between digital transformation and trade credit. We contend that the aforementioned relationship may become more pronounced for firms with financial backgrounds because CEO's financial expertise is crucial for firms to implement optimal policies and contribute to the expansion of the firm's market power (Custodio & Metzger, 2014). In addition, the use of expertise by executives with a financial background can significantly reduce internal control (Oradi et al., 2020) and improve the quality of internal controls. Thus, there may be a less clear relationship between digital transformation and trade credit in firms without financial background executives than in firms with financial background executives.

TABLE 7 Heckman two-stage regression model.

	First-stage	Second-stage			
	DT	RTC	RTC	PTC	PTC
Variables	(1)	(2)	(3)	(4)	(5)
DT		0.0066***	0.0072***	0.0195***	0.0201***
		(6.3315)	(6.8174)	(11.4364)	(11.7187)
MA			−0.0444***		−0.0066
			(−2.6383)		(−0.2260)
DT × MA			0.0151***		0.0087
			(4.2158)		(1.3841)
SIZE	0.0937***	−0.0096***	−0.0088***	−0.0392***	−0.0381***
	(6.3045)	(−9.6613)	(−8.8599)	(−25.9383)	(−25.2227)
LEV	0.1457	0.1606***	0.1561***	0.1453***	0.1394***
	(1.3927)	(34.8109)	(33.8495)	(20.0146)	(19.1743)
GROWTH	0.2878***	−0.0149***	−0.0168***	−0.0414***	−0.0435***
	(7.8549)	(−5.2129)	(−5.8397)	(−9.6946)	(−10.1805)
MTB	−0.0183***	0.0007**	0.0009**	−0.0002	−0.0000
	(−2.9141)	(2.1086)	(2.4978)	(−0.3359)	(−0.0354)
ROA	−0.4290*	0.0583***	0.0443***	0.1993***	0.1823***
	(−1.8109)	(5.3150)	(4.0524)	(10.9126)	(9.9791)
RD	0.0397***	−0.0036***	−0.0033***	−0.0066***	−0.0063***
	(10.8186)	(−10.5879)	(−9.8517)	(−12.5056)	(−11.9245)
TANG	−2.0421***	0.0678***	0.0773***	0.1217***	0.1330***
	(−17.2158)	(3.5044)	(4.0067)	(4.1530)	(4.5436)
CASH	−0.0966	0.0479***	0.0427***	−0.1911***	−0.1991***
	(−0.4018)	(4.4583)	(3.9704)	(−10.9375)	(−11.3278)
TOP1	−0.0044***	0.0005***	0.0005***	0.0004***	0.0005***
	(−4.7059)	(9.2041)	(9.5058)	(5.2238)	(5.4679)
PRO	0.1109***				
	(3.8785)				
IMR		−0.0834***	−0.0888***	−0.2202***	−0.2262***
		(−5.9451)	(−6.3369)	(−10.4400)	(−10.7321)
Constant	−1.4115***	0.2089***	0.1891***	0.9091***	0.8840***
	(−4.2372)	(8.0285)	(7.2888)	(22.9404)	(22.3166)
Year	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes
Observations	10552	10552	10552	10552	10552
Adj R^2		0.3955	0.4011	0.3232	0.3267

Note: Those results support that the theoretical expectations of H1 but not H2, indicating that the findings still hold after accounting for the endogeneity problem due to sample selectivity bias. *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

TABLE 8 Different corporate digital transformation variable.

	RTC		PTC	
Variables	(1)	(2)	(3)	(4)
DT	0.0033***	0.0034***	0.0061***	0.0062***
	(7.2806)	(7.3958)	(8.1586)	(8.1734)
MA		0.0177***		0.0254***
		(4.9275)		(3.9716)
DT × MA		0.0051***		0.0035
		(2.9068)		(1.1056)
SIZE	−0.0054***	−0.0043***	−0.0275***	−0.0262***
	(−8.4173)	(−6.6855)	(−27.6418)	(−25.8532)
LEV	0.1698***	0.1657***	0.1673***	0.1624***
	(38.0446)	(37.2365)	(23.7692)	(23.0881)
GROWTH	−0.0002	−0.0011	−0.0026	−0.0036
	(−0.1392)	(−0.6632)	(−1.0927)	(−1.4859)
MTB	−0.0003	−0.0003	−0.0029***	−0.0029***
	(−1.1172)	(−0.9132)	(−6.1308)	(−5.9899)
ROA	0.0388***	0.0248**	0.1493***	0.1330***
	(3.6285)	(2.3112)	(8.2044)	(7.2917)
RD	−0.0016***	−0.0013***	−0.0014***	−0.0009***
	(−13.2793)	(−9.8693)	(−5.9798)	(−3.9726)
TANG	−0.0446***	−0.0424***	−0.1790***	−0.1765***
	(−9.2336)	(−8.7808)	(−25.0609)	(−24.6544)
CASH	0.0393***	0.0332***	−0.2103***	−0.2180***
	(3.6202)	(3.0583)	(−11.8833)	(−12.2468)
TOP1	0.0003***	0.0003***	−0.0002***	−0.0002***
	(7.2819)	(7.3023)	(−2.9397)	(−2.9116)
Constant	0.1108***	0.0852***	0.6493***	0.6195***
	(7.9103)	(6.0948)	(30.2620)	(28.2733)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	10443	10443	10443	10443
Adj R^2	0.3962	0.4010	0.3146	0.3174

Note: The coefficients of digital transformation are significantly positive at the 1%. The interaction term between digital transformation and managerial ability in Column (2) is significantly positive at the 1% level, but it is not significant in Column (4). The results are highly consistent with the main findings reported earlier. *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

We obtained data from the CSMAR database on whether any of the current directors, supervisors, and senior managers of listed companies have a financial background and constructed a dummy variable $FB_{i,t}$ with a value of 1 for yes and 0 for otherwise. Table 10 shows the corresponding results. According to the results in Columns (1) and (2), the correlation coefficient between digital transformation and received trade credit is higher among firms with financial background, and the Chow test finds a significant difference between the subgroups.

TABLE 9 Lagged explanatory variables and control variables.

	RTC		PTC	
Variables	**(1)**	**(2)**	**(3)**	**(4)**
DT_{t-1}	0.0064***	0.0075***	0.0193***	0.0200***
	(4.9669)	(5.5988)	(9.5649)	(9.7186)
MA		−0.0779***		0.0166
		(−3.2312)		(0.4165)
$DT_{t-1} \times MA$		0.0218***		0.0032
		(4.2578)		(0.3741)
$SIZE_{t-1}$	−0.0043***	−0.0031***	−0.0267***	−0.0253***
	(−5.4542)	(−3.8674)	(−22.5890)	(−20.8886)
LEV_{t-1}	0.1581***	0.1554***	0.1665***	0.1630***
	(28.5378)	(28.2522)	(19.4777)	(19.1079)
$GROWTH_{t-1}$	−0.0021	−0.0030*	−0.0026	−0.0034
	(−1.1601)	(−1.6456)	(−0.9447)	(−1.1959)
MTB_{t-1}	−0.0006	−0.0006	−0.0037***	−0.0037***
	(−1.4854)	(−1.4411)	(−5.8813)	(−5.8474)
ROA_{t-1}	0.0179	0.0101	0.1544***	0.1444***
	(1.3417)	(0.7726)	(6.6244)	(6.2197)
RD_{t-1}	−0.0016***	−0.0012***	−0.0013***	−0.0010***
	(−10.2498)	(−7.9539)	(−4.9555)	(−3.6361)
$TANG_{t-1}$	−0.0504***	−0.0489***	−0.1688***	−0.1669***
	(−8.5598)	(−8.3031)	(−19.5324)	(−19.2972)
$CASH_{t-1}$	0.0467***	0.0405***	−0.2035***	−0.2112***
	(3.6692)	(3.1916)	(−9.6049)	(−9.9292)
$TOP1_{t-1}$	0.0002***	0.0002***	−0.0002***	−0.0002***
	(4.9033)	(4.9482)	(−3.2349)	(−3.1754)
Constant	0.0712***	0.0397**	0.5625***	0.5263***
	(4.0289)	(2.2191)	(21.2288)	(19.3212)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	7643	7643	7643	7643
Adj R^2	0.3795	0.3846	0.3063	0.3088

Note: The results are consistent with the main results reported in Table 4, we can still conclude that digital transformation promotes the use of trade credit. *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

The results in Columns (3) and (4) show that the correlation coefficient between digital transformation and provided trade credit is higher among firms with a financial background, and the Chow test finds a significant difference between the subgroups. The above results suggest that firms with financial background are more affected by digital transformation compared to firms without financial background.

TABLE 10 Heterogeneous analysis: financial background.

	RTC		PTC	
	FB_dummy=1	FB_dummy=0	FB_dummy=1	FB_dummy=0
Variables	(1)	(2)	(3)	(4)
DT	0.0078***	0.0052***	0.0201***	0.0182***
	(5.8856)	(3.1541)	(9.9039)	(5.9848)
SIZE	−0.0058***	−0.0025*	−0.0275***	−0.0255***
	(−7.8619)	(−1.9585)	(−23.6920)	(−13.3531)
LEV	0.1683***	0.1683***	0.1642***	0.1667***
	(30.6297)	(21.7957)	(18.9062)	(13.9347)
GROWTH	−0.0005	−0.0004	−0.0049*	−0.0016
	(−0.2865)	(−0.1197)	(−1.7453)	(−0.3478)
MTB	−0.0005	0.0007	−0.0025***	−0.0023***
	(−1.4262)	(1.2909)	(−4.3543)	(−2.7929)
ROA	0.0464***	0.0101	0.1520***	0.1256***
	(3.7455)	(0.4894)	(7.2847)	(3.5123)
RD	−0.0016***	−0.0018***	−0.0019***	−0.0006
	(−11.2403)	(−7.1143)	(−7.5579)	(−1.2094)
TANG	−0.0369***	−0.0649***	−0.1532***	−0.2140***
	(−6.3356)	(−7.3123)	(−17.7823)	(−16.6083)
CASH	0.0394***	0.0449**	−0.1933***	−0.2281***
	(3.0614)	(2.2692)	(−9.1048)	(−7.2328)
TOP1	0.0003***	0.0003***	−0.0002**	−0.0002
	(5.7301)	(3.8605)	(−2.4383)	(−1.5750)
Constant	0.0888***	0.0351	0.5622***	0.5483***
	(5.3574)	(1.2557)	(21.6290)	(12.9446)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	6975	3442	6975	3442
Adj R^2	0.4033	0.3943	0.3189	0.3311
Chow Test P-statistics	0.0000		0.0000	

Note: In Columns (1) and (2), the correlation coefficient between digital transformation and received trade credit is greater among firms with a financial background; and the results in Columns (3) and (4) show that digital transformation has a greater correlation coefficient with the provide trade credit among companies with financial background. This indicates that digital transformation has a greater impact on trade credit for firms with a financial background than for firms without financial background. *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

4.4.2 | Firm size

This section investigates whether the effects of digital transformation on trade credit for businesses of various sizes are heterogeneous. We believe that digitalization has a stronger positive relationship with trade credit in smaller firms, and the possible reasons are presented as follows: first, small firms have the problem of "*difficult and expensive financing*", and digital transformation can help them to solve this problem by improving their market power and

TABLE 11 Heterogeneous analysis: firm size.

	RTC		PTC	
	Small_dummy=1	Small_dummy=0	Small_dummy=1	Small_dummy=0
Variables	(1)	(2)	(3)	(4)
DT	0.0081***	0.0061***	0.0241***	0.0173***
	(5.8356)	(4.1128)	(9.8094)	(7.4403)
SIZE	−0.0082***	−0.0058***	−0.0323***	−0.0257***
	(−5.8588)	(−4.6708)	(−12.0685)	(−15.3159)
LEV	0.1676***	0.1767***	0.1807***	0.1618***
	(29.3137)	(24.8705)	(18.0065)	(15.9204)
GROWTH	−0.0008	−0.0013	−0.0036	−0.0080**
	(−0.3946)	(−0.5361)	(−1.0294)	(−2.3988)
MTB	−0.0005	−0.0007	−0.0048***	−0.0019***
	(−1.1839)	(−1.3416)	(−7.2678)	(−2.7020)
ROA	0.0272**	0.0744***	0.1161***	0.2223***
	(2.1705)	(3.9599)	(5.0069)	(7.5758)
RD	−0.0016***	−0.0016***	−0.0025***	−0.0006*
	(−10.2376)	(−8.2649)	(−7.8228)	(−1.7856)
TANG	−0.0144**	−0.0657***	−0.1304***	−0.2043***
	(−2.1698)	(−9.3569)	(−11.8454)	(−21.2033)
CASH	0.0191	0.0619***	−0.2571***	−0.1571***
	(1.4799)	(3.4646)	(−10.6676)	(−6.1593)
TOP1	0.0000	0.0005***	−0.0005***	0.0001
	(0.0826)	(8.7803)	(−4.8650)	(0.6601)
Constant	0.1502***	0.0822***	0.6612***	0.5330***
	(4.8598)	(2.9875)	(11.4032)	(14.3129)
Year	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes
Observations	5317	5237	5317	5237
Adj R^2	0.4011	0.3920	0.3103	0.3317
Chow Test P-statistics	0.0000		0.0000	

Note: The results in Columns (1) and (2) indicate that the correlation coefficient for digital transformation is greater among small firms; the results in Columns (3) and (4) indicate that the correlation coefficient for digital transformation is greater among large firms which indicates that the impact of digital transformation and trade credit received or provided should vary across firms of different sizes. *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively.

the quality of their internal controls, thus promoting the adoption of trade credit. Second, an important part of SMEs' assets is invested in accounts receivable (Martinez-Sola et al., 2014); therefore, effective trade credit management is important for SMEs, and digital transformation can help to improve this management capability and contribute to the improvement of firms' profitability.

We create a new dummy variable, $Small_{i,t}$, that equals 1 when the firm is less than the year-industry median and 0 otherwise. Table 11 shows the corresponding results. Columns (1) and (2) show that the correlation coefficient between digital transformation and received trade credit is higher for smaller firms, and the Chow test finds significant

differences between subgroups; Columns (3) and (4) show that the correlation coefficient between digital transformation and provided trade credit is higher for smaller firms, and the Chow test finds significant differences between subgroups. The results validate our above speculation that the impact of digital transformation on trade credit is stronger among small firms.

4.5 | Channel analysis

According to the sections presented above, digital transformation facilitates the application of trade credit, possibly through two channels (i.e., market power and internal control). In this section, we investigate these potential channels using causal steps approach as well as the Sobel test. The investigation of potential mechanisms adds to previous theoretical analyses and complements the study of digital transformation.

4.5.1 | Market power

According to the market power channel, digital transformation can increase a firm's market power. The market share of a company within an industry is directly proportional to its market power (Rhoades, 1985). As a result, this study calculates market power using the proportion of the firm's current year sales revenue to the total sales revenue of the industry as a basis for constructing a dummy variable (*MP*), which is 1 when it is greater than the median and 0 otherwise.

Columns (1)—(3) of Table 12 show the test of mediating effects with provided trade credit (*PTC*) as the dependent variable. Among them, the digital transformation (*DT*) coefficients in Column (1) are significantly positive, indicating that digital transformation facilitates trade credit acquisition. Column (2) shows that the *DT* coefficient is significantly positive, implying that the greater the extent of digital transformation, the greater the firm's market power. The coefficient of market power (*MP*) in Column (3) is significantly positive, with a Sobel test z-value of 3.037 at the 1% level. The *DT* coefficient is significantly positive, and the preceding results demonstrate that the mediating effect exists.

The results of the mediating effect test with *PTC* as the dependent variable are shown in columns (4), (5), and (6) of the table. The coefficient of *DT* in Column (4) is significantly positive, showing that firms are more likely to offer trade credit as a result of digital transformation; the coefficient of *DT* in Column (5) is significantly positive, showing that firms' market power increases as the extent of digital transformation increases; the coefficient of *MP* in Column (6) is significantly positive; and the Sobel test z-value is 3.018 at the 1% significance level. Notably, the *DT* coefficient is markedly positive. These findings support the existence of a mediating effect, indicating that market power is the mediator between digital transformation and trade credit.

4.5.2 | Internal control

Internal control channels demonstrate how digital transformation can improve internal control quality. In accordance with Jiang et al. (2022), we employ the internal control indicators developed by DIB. The index is designed to reflect the current state of internal control embodied by listed companies in China on a trial basis, based on the extent of achievement of the five main goals of internal control compliance, reporting, asset security, operations, and strategy. The index comprehensively reflects the current situation of Chinese listed companies trying to embody internal control. In this study, the proxy variable for internal control quality (*IC*) is the DIB internal control index divided by 100.

Test for mediating effects with *RTC* as the dependent variable is shown in Columns (1)—(3) of Table 13. The significantly positive coefficient of digital transformation (*DT*) in Column (1) means that digital transformation facilitates acquiring trade credit; the significantly positive coefficient of digital transformation (*DT*) in Column (2) means that the

TABLE 12 Potential mechanism analysis: Market power.

Variables	RTC (1)	MP (2)	RTC (3)	PTC (4)	MP (5)	PTC (6)
DT	0.0068***	0.0190***	0.0065***	0.0202***	0.0190***	0.0197***
	(6.5519)	(3.3976)	(6.2930)	(11.8412)	(3.3976)	(11.6224)
MP			0.0151***			0.0232***
			(8.9685)			(8.2224)
SIZE	−0.0051***	0.2070***	−0.0082***	−0.0272***	0.2070***	−0.0320***
	(−7.9637)	(56.7511)	(−11.3573)	(−27.5567)	(56.7511)	(−28.9325)
LEV	0.1682***	0.2132***	0.1650***	0.1653***	0.2132***	0.1604***
	(37.9773)	(8.2962)	(37.2706)	(23.7059)	(8.2962)	(22.9370)
GROWTH	−0.0011	0.0005	−0.0011	−0.0050**	0.0005	−0.0050**
	(−0.7100)	(0.0594)	(−0.7152)	(−2.0969)	(0.0594)	(−2.1123)
MTB	−0.0003	−0.0011	−0.0002	−0.0028***	−0.0011	−0.0028***
	(−0.8575)	(−0.7541)	(−0.8076)	(−6.0001)	(−0.7541)	(−5.9458)
ROA	0.0405***	0.2760***	0.0363***	0.1520***	0.2760***	0.1456***
	(3.8364)	(4.6086)	(3.4533)	(8.4541)	(4.6086)	(8.1887)
RD	−0.0016***	−0.0067***	−0.0015***	−0.0015***	−0.0067***	−0.0014***
	(−13.4420)	(−8.5861)	(−12.6433)	(−6.8367)	(−8.5861)	(−6.1474)
TANG	−0.0440***	−0.0106	−0.0438***	−0.1735***	−0.0106	−0.1732***
	(−9.0800)	(−0.3779)	(−9.0801)	(−24.3075)	(−0.3779)	(−24.3113)
CASH	0.0443***	0.5315***	0.0363***	−0.2005***	0.5315***	−0.2129***
	(4.1227)	(8.8011)	(3.3750)	(−11.4230)	(8.8011)	(−12.1237)
TOP1	0.0003***	0.0005**	0.0003***	−0.0002***	0.0005**	−0.0002***
	(7.1750)	(2.1805)	(7.0187)	(−2.6560)	(2.1805)	(−2.8458)
Constant	0.0779***	−3.6890***	0.1335***	0.5631***	−3.6890***	0.6485***
	(5.4881)	(−46.5045)	(8.6669)	(25.5481)	(−46.5045)	(27.3992)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10553	10553	10553	10554	10553	10553
Adj R^2	0.3935	0.6277	0.3981	0.3171	0.6277	0.3218
Sobel Z		3.037***			3.018***	

Note: The results show that the mediating effect holds, indicating that market power plays a partial mediating effect between digital transformation and trade credit. *, **, and *** indicate the significance levels of 10%, 5%, and 1%, respectively.

greater the extent of digital transformation, the better the quality of internal control; the significantly positive coefficient of internal control quality (*IC*) in Column (3) and the Sobel test z-value of 2.717 is significant at the 1% level. The coefficient of digital transformation (*DT*) is significantly positive, and the above results show that the mediating effect holds.

The results of the mediating effect test with *PTC* as the dependent variable are shown in columns (4), (5), and (6) of the table. Among them, the coefficient of *DT* in Column (4) is significantly positive, suggesting that digital transformation facilitates trade credit provision, whereas the coefficient of *DT* in Column (5) is significantly positive, implying that

TABLE 13 Potential mechanism analysis: Internal control.

Variables	RTC (1)	IC (2)	RTC (3)	PTC (4)	IC (5)	PTC (6)
DT	0.0068***	0.0715***	0.0067***	0.0202***	0.0715***	0.0200***
	(6.5513)	(3.0978)	(6.4295)	(11.8475)	(3.0978)	(11.7454)
IC			0.0022***			0.0032***
			(4.5225)			(4.2947)
SIZE	−0.0051***	0.0838***	−0.0053***	−0.0272***	0.0838***	−0.0274***
	(−7.9634)	(6.3451)	(−8.2736)	(−27.5588)	(6.3451)	(−27.8531)
LEV	0.1682***	−0.0217	0.1684***	0.1653***	−0.0217	0.1654***
	(37.9815)	(−0.2105)	(38.0978)	(23.7037)	(−0.2105)	(23.7987)
GROWTH	−0.0011	0.2257***	−0.0017	−0.0050**	0.2257***	−0.0057**
	(−0.7112)	(6.7309)	(−1.0615)	(−2.0929)	(6.7309)	(−2.4011)
MTB	−0.0003	−0.0426***	−0.0002	−0.0028***	−0.0426***	−0.0027***
	(−0.8574)	(−5.5916)	(−0.5151)	(−6.0005)	(−5.5916)	(−5.7034)
ROA	0.0405***	6.9555***	0.0253**	0.1520***	6.9555***	0.1296***
	(3.8375)	(21.1861)	(2.3473)	(8.4517)	(21.1861)	(6.9605)
RD	−0.0016***	0.0049	−0.0016***	−0.0015***	0.0049	−0.0016***
	(−13.4414)	(1.5981)	(−13.4787)	(−6.8402)	(1.5981)	(−6.9075)
TANG	−0.0440***	−0.4020***	−0.0431***	−0.1735***	−0.4020***	−0.1722***
	(−9.0807)	(−3.5561)	(−8.9084)	(−24.3065)	(−3.5561)	(−24.1631)
CASH	0.0443***	−0.2512	0.0445***	−0.2005***	−0.2512	−0.1998***
	(4.1223)	(−1.0169)	(4.1375)	(−11.4216)	(−1.0169)	(−11.3813)
TOP1	0.0003***	0.0037***	0.0003***	−0.0002***	0.0037***	−0.0002***
	(7.1742)	(4.5916)	(6.9652)	(−2.6519)	(4.5916)	(−2.8433)
Constant	0.0779***	3.9911***	0.0690***	0.5631***	3.9911***	0.5502***
	(5.4882)	(12.6365)	(4.8134)	(25.5480)	(12.6365)	(24.7337)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10554	10553	10553	10554	10553	10553
Adj R^2	0.3936	0.1938	0.3951	0.3171	0.1938	0.3183
Sobel Z		2.717***			2.627***	

Note: The results show that the mediating effect holds, indicating that internal control plays a partial mediating effect between digital transformation and trade credit. *, **, and *** indicate the significance levels of 10%, 5%, and 1%, respectively.

the greater the degree of digital transformation, the higher the quality of internal control. Column (6) has a significant positive coefficient of *IC*, with a Sobel test z-value of 2.627 at the 1% significance level, and a significant positive coefficient of *DT*. The results show that the mediating effect holds, suggesting that internal control mediates the relationship between digital transformation and trade credit to some extent.

5 | CONCLUSIONS

Digital technology acceptance in the digital age affects corporate management performance (Abou-foul et al., 2021) and innovation activities (Urbinati et al., 2020). Changes in business models and shifts in the competitive landscape indicate that digital transformation is a must-have for businesses. According to academic research, digital transformation is putting pressure on traditional businesses and disrupting many markets (Verhoef et al., 2021). As a form of external financing (Bougheas et al., 2009; Cao et al., 2022; Elsilä, 2015) as well as a competitive tool (Fabbri & Klapper, 2016), trade credit has been widely used by firms. As a result, from 2014 to 2020, we examine the impact of digital transformation on trade credit using 10,554 observations from 2509 Chinese A-share listed companies.

In the course of their operations, firms with a higher degree of digital transformation can obtain more trade credit from upstream firms and provide more trade credit to downstream firms, according to our findings. This phenomenon may be due to the following reasons: digital transformation enhances trust between firms and strengthens the cooperation between upstream and downstream; firms with a high degree of digital transformation dominate and have an advantage when agreeing on credit terms and assessing credit risk; digital transformation enhances the quality of corporate internal controls, on the basis of which robust accounting information is important for the assessment of the amount of trade credit to be used. Our study aligns with Chen et al. (2022) and Wu et al. (2022a), who underscores the impact of digital transformation on the information environment, with the former revealing enhanced public information accuracy and analyst coverage. However, our contribution lies in uncovering the specific moderating influence of managerial ability in shaping these relationships. Specifically, we report that the managerial ability has a positive moderating effect on the relationship between digital transformation and received trade credit but not on the relationship between digital transformation and provided trade credit. Finally, we performed robustness tests, examined the heterogeneity effect of financial background and firm size, and identified the channel through which the digital transformation of corporates affects trade credit. Overall, our findings demonstrate the importance of digital transformation for companies in the digital trend, which assists them in broadening their financing channels and thus creating value. Our paper complementing past research by Chen and Hao (2022), exploring digital transformation from the perspective of board characteristics, laid the groundwork for understanding its impact on environmental performance. Our study advances this understanding by demonstrating how managerial ability acts as a critical moderator in the nexus between digital transformation and trade credit. Furthermore, we add to previous studies by Khoo and Cheung (2022) and Cheng and Cheung (2021) that offer valuable insights into the intricate connections between managerial ability, financial choices, and firm outcomes, emphasizing the nuanced role of managerial ability in trade credit dynamics and risk management.

Finally, we acknowledge, that the annual financial reports of enterprises are prepared by management, who may use ambiguous statements for reasons such as avoiding technical leakage; therefore, the textual information may not be sufficiently comprehensive to reflect the degree of digital transformation. Future research could look for more comprehensive and objective indicators as proxy variables for corporate digital transformation; for example, Jiang et al. (2022) use the proportion of intangible assets related to digital transformation to measure the degree of digitalization of a company. Our study explores the possible moderating role between digital transformation and trade credit using a more comprehensive indicator (managerial ability). The heterogeneous role of financial background and firm size is explored in the subsequent sections. Future research could explore the impact on firm digitalization or trade credit in terms of other aspects of managerial traits. For example, Kong et al. (2020) explore the influence of the CEO's hometown ties to suppliers on firms' availability to trade credit, and factors such as gender diversity in management, tenure, and career experience also merit further exploration. Finally, the research data in this study are from Chinese A-share listed firms, and the findings hold only in this context adding to prior work by Niu et al. (2023), Zhai et al. (2022), among others. Future research could be tested using a broader sample if data from other countries are available.

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