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Spillover effect of digital transformation along the supply chain: From the perspective of suppliers' audit fees

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ABSTRACT

This research contributes to understanding the spillover effect of customer digital transformation along the supply chain. We take a supply chain relationship perspective to explore the influence of customers' digital transformation on suppliers' audit fees and find a significant reduction in such fees when customers undergo digital transformation. An economic mechanism analysis reveals that this transformation reduces audit fees by lowering the risks and costs encountered by auditors. This is achieved by mitigating suppliers' business risks and improving earnings quality. Heterogeneity analysis reveals that the impact of customers' digital transformation on suppliers' audit fees is more pronounced when the supply chain is geographically distant, suppliers with more specific investments and with high levels of market competition.

1. Introduction

Digital transformation involves shifting from a traditional "industrialized" management model to a digital management model (Verhoef et al., 2021). This transition goes beyond simply applying digital technologies to technical aspects of a business and involves a complete restructuring of business models and operational management. Research on the economic consequences of digital transformation emphasizes its potential influence on the quality of corporate disclosures and business risks. For example, digital technologies can improve operational management, promote networked and flattened organizational structures (Nambisan et al., 2019),

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increase corporate disclosure transparency and the quality of accounting information and enhance communication, production and operational efficiency (Wu et al., 2021; Chen et al., 2022a). By digitally collecting and analyzing data, firms can effectively visualize information, enhance interdepartmental coordination, refine risk control processes, mitigate operational risks and reduce management fraud and decision-making errors that lead to losses, thereby enhancing their market reputation (Manita et al., 2020; Zhou and Li, 2023). Most studies focus on the direct effects of digital transformation on firms' risk responses and information transfer capabilities, while its broader effects on the supply chain have not been sufficiently investigated (Guo et al., 2023).

The production operations of suppliers and their financial decisions are influenced and informed by their customers, who therefore play a vital role in the supply chain (Ak and Patatoukas, 2016). Investing in supply chain relationships promotes the economic interdependence of suppliers and customers. The value of such investment depends on customers' growth prospects, and ensuring the stability of their businesses can lead to higher expected returns from supply chain collaboration. Conversely, if customers face business challenges or go bankrupt, they can jeopardize the value of the assets allocated by suppliers (Raman and Shahrur, 2008). This increases suppliers' cash flow and operational risk (Itzkowitz, 2013). Thus, suppliers are highly sensitive to the operations and activities of their customers. The risks and information associated with customers can generate a spillover effect in the supply chain, which can then trigger cascading changes in suppliers' operational risks and influence their investments and financial decisions (Hertzel et al., 2008; Jacobson and von Schedvin, 2015; Chiu et al., 2019). By gaining access to more transparent customer information, suppliers can better forecast customer demand, reduce transaction costs, alleviate shortages and losses and enhance production efficiency and inventory management (Yang et al., 2020). Digital transformation can have positive effects on business risks and disclosure quality, in addition to the supply chain, but does the digital transformation of customer businesses also lead to additional spillover effects on suppliers?

The volume of literature examining audit fees has increased substantially in recent years, with a particular focus on the supply chain. Establishing stable relationships within a supply chain promotes integration (Krishnan et al., 2019), and some customers of an audited firm can help to reduce its audit fees, for example, if they are associated with the government, as this will have a positive influence on its market signals and credibility (Dou et al., 2019). Supply chain information spillover occurs when customers disclose non-compliance, and the resulting external transmission of negative information can exacerbate supply chain risk (Zhang and Smith, 2023), which in turn can increase suppliers' audit risks and costs. This suggests that suppliers and audit firms should carefully consider the risk contained in information provided by customers. We therefore investigate the role of customers' digital transformation in the impact of supply chain risk and information spillover on suppliers' audit fees.

We assess how the audit fees of A-share listed companies in Shanghai and Shenzhen from 2007 to 2020 are affected by their customers' digital transformation. We analyze publicly disclosed information about these suppliers' top five customers and find that digital transformation plays a significant role in reducing their audit fees. We confirm the validity of our findings through robustness tests and endogeneity treatments and propose an economic mechanism through which customers' digital transformation can mitigate suppliers' operational risk and earnings management via a supply chain spillover effect, leading to a decrease in audit risks and costs for suppliers. A heterogeneity analysis further demonstrates that the influence of digital transformation is more pronounced when there is a greater geographic distance between suppliers and customers, higher specific investment in supply chain relationships and more intense supplier market competition than in other situations. These findings provide additional evidence that digital transformation can mitigate business risks, enhance information sharing and optimize supply chain efficiency through the spillover effect.

This study contributes to several key research areas. First, previous studies mainly focus on the direct effects of digital transformation, such as improving firms' data processing capabilities, enhancing the efficiency of information transfer and reducing business risks (Chen et al., 2020; Zhou and Li, 2023). However, we examine the spillover effect of customers' digital transformation on suppliers' financial behavior, and thus its indirect influence on stakeholders. As customer–supplier relationships such as effective supply chain collaboration are economically important and can help to ensure that firms are competitive, this study provides valuable insights into the economic consequences of digital transformation by examining supply chain dynamics.

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Second, we take a novel approach to examining the factors that influence audit fees. Previous studies indicate that the application of digital technologies can enhance corporate information transparency and decision-making accuracy and reduce business risks, which leads to lower audit fees (Zhang et al., 2021). Our study spans corporate boundaries and investigates how the digital transformation of downstream customers affects upstream suppliers' audit fees in supply chain relationships. This offers a new perspective on the factors that influence audit fees.

Third, this study makes a valuable contribution to the literature on supply chain spillovers. Previous research mainly focuses on the link between disclosure behavior, such as customer earnings announcements and annual reports, and suppliers. Studies of the spillover effects of digital transformation mainly examine supplier incentives and research and development (R&D) innovations (Guo et al., 2023). However, we take a different approach and investigate the relationship between suppliers' audit fees and their customers' digital transformation. We therefore further reveal the economic outcomes of supply chain spillovers resulting from digital transformation, and we confirm the positive impact of such transformation on supply chain synergy by considering audit fees.

The remainder of this paper is organized as follows. In Section 2, we review the related literature and provide the theoretical hypotheses. Section 3 describes the study's data, samples and research design. Section 4 provides the empirical results. Section 5 presents our further analyses. Finally, Section 6 concludes the study.

2. Literature review and hypothesis development

2.1. Literature review

2.1.1. Digital transformation and audit fees

An audit fee is the price for audit services agreed between the auditor and a business entity. It includes a premium to compensate for risks (Simunic, 1980). When a business entity faces a higher level of risk, its accounting earnings include more uncertainty, resulting in an increased risk of misrepresentation in its financial statements. The business risk of the audited entity is an important source of audit risk (Simunic, 1980). Digital transformation involves applying technologies such as artificial intelligence, blockchain technology, cloud computing and big data to collect information, analyze data and support decision-making. This leads to changes in organizational management styles, production management models and business strategies (Verhoef et al., 2021), along with extensive improvements in manufacturing, sales logistics and product innovation (Goldfarb and Tucker, 2019). Studies of digital transformation typically consider its impact on audit costs and audit risks.

Digital transformation has various benefits that can lead to reduced audit costs. Eliminating data silos across departments can help organizations identify potential opportunities and risks in dynamic environments. They can then draw on the more integrated data to inform risk assessment and operational decision-making (Tian et al., 2022). This can also enhance the level of collaboration in and the resilience of the supply chain (Guo et al., 2023) and mitigate operational risks (Zhang et al., 2021; Zhou and Li, 2023), which can result in lower audit fees. Through digital technologies, large amounts of unstructured and non-standardized data can be structured and standardized, which helps to reduce information asymmetry and enhances the quality of information disclosure, which also lowers audit risks and costs (Wu et al., 2021; Zhang et al., 2021; Wen et al., 2023) and thus audit fees.

However, digital transformation can also increase audit costs. The uncertainty associated with the transformation process, along with rapid product and technology updates, can intensify market competition and elevate operational risks for firms (Matt et al., 2015; Nambisan et al., 2019). If management and employees lack sufficient digital knowledge and skills or make biased predictions about market trends, operational risks can further increase. Digital transformation also has the potential to make firms' financial systems more complex, which may increase the likelihood of financial manipulation tactics such as earnings management. The firms' auditors must then extend the scope of their audits and must conduct additional procedures, leading to delays and decreased efficiency (Leng and Zhang, 2024).

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2.1.2. Supply chain spillover effect

Effective corporate production and business operations require smooth coordination and cooperation throughout the supply chain. To gain a competitive advantage in the market, leveraging the strengths of each participant in the supply chain will enhance its resilience. Suppliers rely heavily on orders from their major customers as their primary source of sales revenue and cash flow, and thus these customers have a major impact on their operations and overall development (Ak and Patatoukas, 2016). Customers and suppliers are interdependent and make substantial relationship-specific investments (Raman and Shahrur, 2008). This interdependence affects both customers and suppliers, leading to the phenomenon of "prosperity for all, loss for all."

The presence of operational risks associated with customers in the supply chain has major implications, as customers serve as vital economic resources for suppliers. They influence various aspects of supplier operations such as performance and product pricing (Ak and Patatoukas, 2016) and play a role in suppliers' financial decisions, including those regarding capital structure (Itzkowitz, 2013). Any risks they encounter can also spill over to suppliers. For instance, if a customer faces financial difficulties or goes bankrupt due to poor operational performance, this risk can propagate throughout the supply chain and affect upstream suppliers who may encounter delays in collecting accounts receivable, which can have adverse effects on their cash flow and borrowing capacity (Battiston et al., 2007; Campello and Gao, 2017). Thus, suppliers may face financial distress (Hertzel et al., 2008). Peng and Wang (2018) further emphasize that a decline in customers' stock prices can also have repercussions for suppliers, especially when they are not adequately resilient to such risk.

Customers also transmit information to suppliers, which can result in information spillovers. If their customers publicly disclose high-quality information, suppliers can forecast demand more accurately, minimize the shortages or losses brought by slow-selling products and make optimal decisions regarding production and inventory. This helps to reduce the "bullwhip effect" and to optimize suppliers' investment efficiency and operational performance (Chiu et al., 2019; Yang et al., 2020; Chen et al., 2022a). If customers exceed expectations when announcing earnings, suppliers will increase their levels of disclosure to divert the attention of external investors away from any potential operational risks (Cho et al., 2020). If customers disclose negative information, the suppliers may increase their cash holdings (Di et al., 2020) or reduce their R&D activities (Chen et al., 2022b) to mitigate the potential negative effects. Such disclosure can increase the operational risks of supplier firms, which then results in higher audit fees (Zhang and Smith, 2023).

2.2. Hypothesis development

Customers play a vital role in the supply chain and represent key stakeholders for suppliers. They possess valuable insights into market demand and future development prospects (Lee et al., 1997), and in addition to being important sources of revenue for suppliers, they dictate production and sales strategies. Suppliers strategically align their production with customer demand and rely on it to sustain their business operations. They aim to establish stable and beneficial collaborations by investing in relationship-specific assets that enable the creation of unique or customized goods and services (Raman and Shahrur, 2008). The disruption of these supply chain relationships can lead to substantial switching costs and economic losses (Dou et al., 2013), and thus the risks associated with customers can affect the overall efficiency of the entire supply chain (Hertzel et al., 2008; Xuan and Xiongyuan, 2018). Information related to customer risk is therefore valuable and influences suppliers' economic interests and decision-making processes (Chiu et al., 2019) and is extremely important for auditors when evaluating these suppliers (Zhang and Smith, 2023). Customer information can also spill over into the supply chain, and its effective disclosure can enhance the accuracy of suppliers' demand forecasts and mitigate the supply–demand discrepancies, thereby improving decision-making efficiency and overall business performance (Yang et al., 2020). We propose that the spillover effect of customers' digital transformation influences suppliers' audit risks and audit costs, and thus their audit fees.

First, customers' digital transformation has the potential to alleviate suppliers' audit risks. In terms of supply chain risk spillovers, customers facing higher levels of risk will have reduced purchasing power, which can result in financial liquidity constraints. In turn, this can have a detrimental impact on suppliers' sales performance, leading to inventory backlogs and extended payment terms. Consequently, the suppliers' overall business risk will increase (Gosman et al., 2004). If customers face bankruptcy due to mismanagement, suppliers

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will be burdened with sunk costs such as bad receivables and disrupted supply chain connections, thereby exacerbating operational problems (Battiston et al., 2007). Digital transformation can help to enhance the efficiency of information feedback and market responsiveness (Verhoef et al., 2021). This allows for enhanced market sensitivity and the timely identification of opportunities and risks, thus facilitating rational resource allocation (Loebbecke and Picot, 2015). Thus, customers' digital transformation strengthens information coordination and market perception capabilities, increases resilience to business risks, optimizes decision-making efficiency and reduces the likelihood of fluctuations in customer performance. The risk of bankruptcy or liquidation is thus mitigated, reducing suppliers' exposure to customer-related business risks.

Digital transformation can also facilitate effective information-sharing and enhance the efficiency of supply chain collaboration (Goldfarb and Tucker, 2019). Through the resulting information spillover, they can communicate information more accurately to suppliers (Guo et al., 2023). Through this information, suppliers may gain access to actual customer sales data and business strategies, which can enable them to make accurate market demand predictions and swiftly adjust their own strategies (Ngo et al., 2023). Information collaboration within the supply chain reduces the revenue volatility caused by suppliers' biased demand forecasts and decision-making errors (Yang et al., 2020) and ensures smooth turnover of working capital (Gu et al., 2022), which then alleviates the pressure on suppliers' management teams to manipulate earnings in response to performance demands.

To summarize, customers' digital transformation can effectively lead to supply chain information spillovers, which in turn reduces the business risks faced by supplier firms and discourages their earnings manipulation. Some scholars argue that the operational risks and earnings manipulation behavior of audited entities significantly affect their overall audit risk (Simunic, 1980; Defond and Lennox, 2011). The digital transformation of customers can thus help to mitigate audit risk for supplier firms by decreasing auditors' perceptions of risk, ultimately resulting in lower audit fees.

The digital transformation of customer firms also improves their own production, operational efficiency and risk response capabilities. This can help to reduce the uncertainty caused by the impact of any potential customer risks on suppliers and enhance the risk coordination ability of the entire supply chain. Therefore, the positive effect of supply chain integration enables suppliers' funds to circulate normally and maintain good liquidity (Gu et al., 2022). Their operational performance and market value are then guaranteed, which serves to reduce the opportunistic behavior of their management in terms of manipulating financial statements due to performance assessment and reputational pressure, and thus enhances financial information transparency. Improvements in financial statement quality make it easier for auditors to collect relevant evidence and thus make audit judgments (Zhang et al., 2021), thereby reducing the costs for their services and thus the audit fees paid by suppliers.

From the above analysis, we propose the following hypothesis:

Hypothesis H1a: Customers' digital transformation reduces suppliers' audit fees.

However, customer digital transformation may also increase suppliers' audit fees. First, an increase in supply chain risks, and specifically operational risks, can result from customer digitalization, as they may need to find new avenues for growth, make long-term investments and engage in activities that involve trial-and-error (Goldfarb and Tucker, 2019). These endeavors can result in short-term financial setbacks and an increase in operational risks, which then impact suppliers. Second, customers' digital transformation can lead suppliers to incur higher operational expenses due to the spillover of information within the supply chain. The changes in resources and information structure that customers seek in their pursuit of collaborative relationships may not necessarily result in more efficient data use. The lack of compatibility or inadequate interpretive ability between customer and supplier information systems can impede communication, leading to increased operational risks and costs for suppliers. Auditors must then conduct more comprehensive testing and auditing, thus leading to greater audit risk (Dou et al., 2019). Consequently, auditors may charge suppliers additional fees due to the operational risks and increased workload caused by customers' digital transformation. Thus, the financial implications for suppliers may be extensive.

Based on the arguments above, we propose the following hypothesis:

Hypothesis H1b: Customers' digital transformation increases suppliers' audit fees.

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3. Data, sample and research design

3.1. Data and sample

The China Securities Regulatory Commission (CSRC) does not require listed companies to disclose customer information. However, since 2007, most listed companies disclose information about their major customers. In this study, we focused on Shanghai and Shenzhen A-share listed supplier companies from 2007 to 2020. We selected sample observations based on full disclosure of the names and sales figures of the top five customers. We followed Di et al. (2020) and included observations from suppliers with listed customers by applying the following exclusion criteria: (1) those listed for less than one year; (2) those classified as financial companies; (3) those designated as Special Treatment (ST) and Starred Special Treatment (*ST); and (4) those with missing variables. After the screening process, we obtained a final sample of 1,419 firm-year observations from A-share listed companies in Shanghai and Shenzhen. Supply chain, corporate financial- and corporate governance-related data were obtained from the CSMAR database. We winsorized all continuous variables at the 1st and 99th percentiles to mitigate the impact of extreme values.

3.2. Measures of customer digital transformation

We followed Di et al. (2020) and Wu et al. (2021) to develop an indicator of customer digital transformation. We examined the frequency of terms related to digital transformation in the annual reports of the listed customer companies disclosed by suppliers. The frequencies of these terms were first calculated using the digital transformation thesaurus developed by Wu et al. (2021), who we also followed to calculate the corporate digital transformation indicator. This involved dividing the total occurrence of digital transformation words in the annual reports by the total word count, multiplying by 100 and taking the natural logarithm of the resulting figure. We then computed customer digital transformation indicators, as outlined by Di et al. (2020), with adjustments based on the sales share of the top five customers as disclosed by the suppliers. This process involved three steps: (1) identifying and collecting data on the top five customers mentioned in a supplier's annual report, and we retained the sample if listed firms were included; (2) we calculated weights for customers identified as listed firms based on the proportion of sales to them relative to the total sales of the top five customers; and (3) we computed the digital transformation metrics for each customer using these weights, resulting in weighted sums that represented our customer digital transformation variables (*CusDigit*1 and *CusDigit*2).

3.3. Research design

We constructed the following model to examine the relationship between customer digital transformation and supplier audit fees:

$$Lnfee_{i,t} = \beta_0 + \beta_1 CusDigit_{i,t} + \sum Controls_{i,t} + \sum Firm_i + \sum year_t + \varepsilon_{i,t} \quad (1)$$

where the dependent variable *Lnfee* is the natural logarithm of the audit fees disclosed in the supplier's annual report. The independent variable *CusDigit* represents the customer digital transformation variables (*CusDigit*1 and *CusDigit*2). We also controlled for the following variables: a supplier's asset size (*Size*), leverage (*Lev*), cash flow (*CF*), current ratio (*Current*), return on total assets (*ROA*), percentage of accounts receivable (*Receiv*), whether the supplier is in a loss position (*Loss*), the supplier's age of establishment (*Age*), business segment (*BusSeg*), digital transformation (*Digit*), board size (*Board*), percentage of independent directors (*Indrt*), ownership nature (*SOE*), customer concentration (*CC*), customer stock market return (*CusRet*), customer sales revenue volatility (*stdCusGro*), whether the supplier changes its accounting firm (*Change*), whether the supplier is audited by an international Big4 firm (*Big*4), whether the customer and supplier share the same auditor (*ComAud*) and marketization degree (*MKT*). Table 1 provides more details on each variable. We also controlled for firm fixed effects (*Firm*) and year fixed effects (*Year*) and cluster-adjusted the standard errors of the regression results at the firm level.

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Table 1
Variable definitions.

Variables	Definition
Panel A: Independent and dependent variables	
Lnfee	Natural logarithm of supplier audit costs
*CusDigit*1	Weighted average of customer sales share (number of digital transformation-related terms in the annual report/total number of terms in the annual report × 100)
*CusDigit*2	Weighted average of the logarithm of the number of digital transformation-related terms in the annual report calculated as a percentage of customer sales
Panel B: Control variables	
Size	Natural logarithm of suppliers' total assets
Lev	Ratio of suppliers' total liabilities to total assets
CF	Ratio of suppliers' cash flow from operating activities to total assets
Current	Ratio of suppliers' current assets to current liabilities
ROA	Ratio of suppliers' net profit to total assets
Receiv	Ratio of suppliers' net accounts receivable to total assets
Loss	If the supplier's net profit for the year is less than 0, it takes the value of 1 and 0 otherwise
Age	Suppliers' year of establishment divided by 100
BusSeg	Suppliers' number of business segments
Digit	A supplier's share of digital transformation words, i.e., (number of digital transformation-related terms in the supplier's annual report/total number of terms in the supplier's annual report) × 100
Board	Natural logarithm of the number of directors of the supplier company
Indrt	Ratio of the number of suppliers' independent directors to the total number of directors
Sep	Proportion of control of the listed company owned by the beneficial owner of the supplier company minus proportion of ownership of the listed company owned by the beneficial owner of the supplier company
SOE	The nature of the supplier's property rights, which takes the value of 1 if it is a state-owned enterprise and 0 otherwise
CC	Sum of squared ratios of sales to total sales from the top five customers
CusRet	Equity return on customers weighted by customers' share of sales
stdCusGro	Volatility of sales revenue from customers weighted by their share of sales
Change	If there is a change in the supplier's accounting firm, it takes the value of 1 and 0 otherwise
*Big*4	If the supplier is audited by a Big 4 accounting firm, it takes the value of 1 and 0 otherwise
ComAud	If there is a common auditor between the customer and the supplier, it takes the value of 1 and 0 otherwise
MKT	If the marketization index is greater than the sample period average, it takes the value of 1 and 0 otherwise

4. Empirical results

4.1. Descriptive statistics

Table 2 presents the descriptive statistics of the main variables. The means of *CusDigit*1 and *CusDigit*2 are 0.013 and 0.713, respectively, with standard deviations of 0.029 and 1.146. The dependent variable, audit fees, has a mean of 13.574 and a standard deviation of 0.685. These statistics suggest significant variations in both customer digitization transformation and audit fees across different supplier firms, consistent with previous research (Di et al., 2020). The remaining control variables also align with those in other studies (Di et al., 2020; Zhang et al., 2021).

4.2. Baseline results

Table 3 presents the regression results for the effect of customer digital transformation on supplier audit fees. The estimated regression coefficients for *CusDigit* when controlling for *Firm* and *Year* are –1.132 and –0.030, respectively, and are both statistically significant at the 1 % level. These results suggest that customers' digital transformation significantly reduces suppliers' audit fees, thus preliminarily confirming H1a. This finding has economic significance: for every standard deviation increase in *CusDigit* (0.029 and 1.146), the standard deviation of supplier audit fees (0.685) will decrease by 4.79 % and 5.02 %, respectively.[1]

[1] Taking the coefficients on *CusDigit*1 from column (1) of Table 3 as an example, a one standard deviation increase in *CusDigit*1 (0.029), relative to the standard deviation of *Lnfee* (0.685), results in a decrease in *Lnfee* of 4.79%, calculated as 1.132 × 0.029/0.685.

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Table 2
Descriptive statistic.

Variable	N	Mean	SD	P25	Median	P75	Max
Lnfee	1,419	13.574	0.685	13.122	13.459	13.955	15.956
*CusDigit*1	1,419	0.013	0.029	0.000	0.000	0.010	0.170
*CusDigit*2	1,419	0.713	1.146	0.000	0.000	1.147	4.248
Size	1,419	21.920	1.223	20.987	21.759	22.690	25.114
Lev	1,419	0.421	0.213	0.254	0.410	0.585	0.902
CF	1,419	0.040	0.065	0.003	0.039	0.076	0.214
Current	1,419	2.668	3.243	1.086	1.657	2.839	23.189
ROA	1,419	0.038	0.065	0.014	0.037	0.068	0.203
Receiv	1,419	0.137	0.112	0.046	0.116	0.201	0.528
Loss	1,419	0.102	0.303	0.000	0.000	0.000	1.000
Age	1,419	0.153	0.058	0.110	0.150	0.190	0.310
BusSeg	1,419	0.702	1.558	0.000	0.000	0.000	7.000
Digit	1,419	0.024	0.060	0.000	0.000	0.013	0.326
Board	1,419	2.178	0.175	2.079	2.197	2.197	2.708
Indrt	1,419	0.368	0.050	0.333	0.333	0.400	0.556
Sep	1,419	5.657	8.080	0.000	0.000	10.659	29.936
SOE	1,419	0.414	0.493	0.000	0.000	1.000	1.000
CC	1,419	5.624	9.829	0.540	1.679	5.826	52.604
CusRet	1,419	0.096	0.405	–0.105	0.000	0.188	1.667
stdCusGro	1,419	0.075	0.099	0.000	0.044	0.105	0.471
Change	1,419	0.129	0.335	0.000	0.000	0.000	1.000
*Big*4	1,419	0.044	0.204	0.000	0.000	0.000	1.000
ComAud	1,419	0.014	0.118	0.000	0.000	0.000	1.000
MKT	1,419	0.550	0.498	0.000	1.000	1.000	1.000

4.3. Robustness tests

4.3.1. Alternative measures of customer digital transformation

To enhance the robustness of our findings, we took two approaches to recalibrate customer digital transformation. First, following Yuan et al. (2021), we divided the total number of occurrences of digital transformation terms in the management discussion and analysis (MD&A) sections of the top five listed customers disclosed by the suppliers by the total MD&A word count and multiplied by 100. The resulting number of digital transformation terms in the MD&A sections was then transformed using the natural logarithm and weighted by the customer's sales share, to compute the customer's level of digital transformation (*CusDigit*3 and *CusDigit*4). Second, following the methodology proposed by Di et al. (2020), equal weights were assigned to calculate the proportion of digitized vocabulary in annual customer reports (*CusDT*1) and the logarithm of the number of occurrences of digitized vocabulary in annual customer reports (*CusDT*2). The robustness regression results presented in Table 4 demonstrate that regardless of the approach used to compute customer digital transformation, the coefficient on *Lnfee* consistently and significantly shows a negative relationship, significant at least at the 5 % level. These findings support H1a, indicating that customers' digital transformation has a diminishing effect on suppliers' audit fees.

4.3.2. Alternative measure of supplier audit fees

To account for the effects on audit fees of variations in auditor workload attributed to supplier size, we used suppliers' audit fees adjusted for operating revenue as the explanatory variable (*AuditFee*) in our robustness test. Columns (1) and (2) of Table 5 present the results of this robustness test with the alternative measure of supplier audit fees. The coefficient of *CusDigit* on *AuditFee* remains statistically significant, at least at the 5 % level.

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Table 3
Customer digital transformation and supplier audit fees.

Variable	(1) *Lnfee*	(2) *Lnfee*
*CusDigit*1	–1.132***	
	(–2.77)	
*CusDigit*2		–0.030***
		(–2.68)
Size	0.342***	0.343***
	(7.63)	(7.63)
Lev	–0.098	–0.100
	(–0.60)	(–0.61)
CF	0.366**	0.355**
	(2.51)	(2.42)
Current	–0.008*	–0.008*
	(–1.89)	(–1.88)
ROA	0.022	0.019
	(0.08)	(0.07)
Receiv	0.313	0.320
	(1.13)	(1.14)
Loss	0.080*	0.078*
	(1.92)	(1.85)
Age	6.752***	6.745***
	(4.18)	(4.09)
BusSeg	–0.006	–0.006
	(–0.63)	(–0.66)
Digit	–0.098	–0.091
	(–0.39)	(–0.36)
Board	0.189	0.181
	(1.55)	(1.48)
Indrt	0.301	0.283
	(0.87)	(0.83)
Sep	–0.000	–0.000
	(–0.09)	(–0.14)
SOE	0.221*	0.216*
	(1.89)	(1.81)
CC	–0.004**	–0.004**
	(–2.56)	(–2.58)
CusRet	–0.023	–0.023
	(–1.18)	(–1.18)
stdCusGro	0.129	0.128
	(1.36)	(1.36)
Change	–0.032	–0.030
	(–1.38)	(–1.29)
*Big*4	0.300***	0.304***
	(3.01)	(3.09)
ComAud	0.138	0.137
	(1.51)	(1.47)
MKT	0.135***	0.132***
	(3.07)	(2.97)
Constant	4.375***	4.391***
	(4.02)	(4.04)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1,419	1,419
Adj. R^2	0.240	0.239

Notes: Standard errors are clustered at the firm level. *statistically significant at the 10%, **statistically significant at the 5% and ***statistically significant at the 1% level. The t-statistics are provided in parentheses, and the same notation is used throughout the text.

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Table 4
Robustness test: Alternative measurement of independent variables.

Variable	(1) *Lnfee*	(2) *Lnfee*	(3) *Lnfee*	(4) *Lnfee*
*CusDigit*3	–0.177**			
	(–2.19)			
*CusDigit*4		–0.036***		
		(–3.09)		
*CusDT*1			–1.125***	
			(–2.66)	
*CusDT*2				–0.031***
				(–2.71)
Size	0.340***	0.340***	0.343***	0.344***
	(7.54)	(7.60)	(7.64)	(7.67)
Lev	–0.099	–0.103	–0.098	–0.101
	(–0.60)	(–0.63)	(–0.60)	(–0.61)
CF	0.366**	0.359**	0.364**	0.357**
	(2.51)	(2.46)	(2.50)	(2.44)
Current	–0.008*	–0.008*	–0.008*	–0.008*
	(–1.88)	(–1.90)	(–1.90)	(–1.90)
ROA	0.010	0.027	0.021	0.017
	(0.04)	(0.10)	(0.07)	(0.06)
Receiv	0.324	0.337	0.311	0.317
	(1.17)	(1.22)	(1.12)	(1.14)
Loss	0.078*	0.079*	0.081*	0.078*
	(1.87)	(1.88)	(1.93)	(1.86)
Age	6.709***	6.726***	6.753***	6.750***
	(4.19)	(4.13)	(4.19)	(4.11)
BusSeg	–0.006	–0.007	–0.006	–0.006
	(–0.65)	(–0.74)	(–0.65)	(–0.67)
Digit	–0.157	–0.150	–0.102	–0.093
	(–0.60)	(–0.58)	(–0.40)	(–0.37)
Board	0.187	0.177	0.190	0.182
	(1.52)	(1.45)	(1.56)	(1.48)
Indrt	0.273	0.248	0.298	0.282
	(0.79)	(0.73)	(0.86)	(0.82)
Sep	–0.000	–0.000	–0.000	–0.000
	(–0.11)	(–0.14)	(–0.09)	(–0.14)
SOE	0.215*	0.212*	0.221*	0.216*
	(1.86)	(1.82)	(1.89)	(1.81)
CC	–0.004**	–0.004**	–0.004**	–0.004**
	(–2.45)	(–2.51)	(–2.53)	(–2.57)
CusRet	–0.025	–0.027	–0.023	–0.023
	(–1.27)	(–1.37)	(–1.18)	(–1.17)
stdCusGro	0.130	0.135	0.129	0.128
	(1.37)	(1.43)	(1.35)	(1.36)
Change	–0.031	–0.032	–0.032	–0.030
	(–1.35)	(–1.38)	(–1.39)	(–1.32)
*Big*4	0.305***	0.310***	0.301***	0.303***
	(3.10)	(3.09)	(3.01)	(3.08)
ComAud	0.138	0.132	0.138	0.138
	(1.57)	(1.45)	(1.52)	(1.48)
MKT	0.137***	0.140***	0.135***	0.132***
	(3.11)	(3.15)	(3.06)	(2.97)
Constant	4.448***	4.474***	4.371***	4.373***
	(4.11)	(4.15)	(4.02)	(4.04)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,419	1,419	1,419	1,419
Adj. R^2	0.237	0.241	0.239	0.240

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Table 5
Robustness tests: Alternative measure of the dependent variable and excluding the 2019 and 2020 samples.

Variable	(1) *AuditFee*	(2) *AuditFee*	(3) *Lnfee*	(4) *Lnfee*
*CusDigit*1	–0.302**		–1.048**	
	(–2.38)		(–2.19)	
*CusDigit*2		–0.008***		–0.033***
		(–2.59)		(–2.85)
Size	–0.060***	–0.060***	0.349***	0.350***
	(–3.79)	(–3.79)	(7.62)	(7.75)
Lev	0.099**	0.099*	–0.076	–0.081
	(1.97)	(1.96)	(–0.45)	(–0.47)
CF	0.047	0.044	0.346**	0.334**
	(0.69)	(0.65)	(2.19)	(2.10)
Current	0.003	0.003*	–0.004	–0.004
	(1.62)	(1.66)	(–0.93)	(–0.92)
ROA	–0.436***	–0.436***	0.220	0.218
	(–3.82)	(–3.84)	(0.72)	(0.71)
Receiv	–0.178	–0.176	0.265	0.264
	(–1.56)	(–1.54)	(0.94)	(0.93)
Loss	0.005	0.004	0.061*	0.059
	(0.42)	(0.37)	(1.65)	(1.60)
Age	1.009	1.010	6.177***	6.372***
	(1.53)	(1.49)	(3.45)	(3.45)
BusSeg	–0.000	–0.000	–0.006	–0.007
	(–0.10)	(–0.14)	(–0.72)	(–0.79)
Digit	0.001	0.004	–0.032	–0.010
	(0.02)	(0.06)	(–0.12)	(–0.04)
Board	0.018	0.016	0.172	0.167
	(0.53)	(0.47)	(1.29)	(1.25)
Indrt	0.012	0.008	0.167	0.165
	(0.12)	(0.08)	(0.43)	(0.43)
Sep	–0.000	–0.000	–0.003	–0.003
	(–0.19)	(–0.24)	(–0.81)	(–0.84)
SOE	–0.042	–0.043	0.258	0.260
	(–1.12)	(–1.12)	(1.27)	(1.26)
CC	–0.002*	–0.002*	–0.004*	–0.004**
	(–1.77)	(–1.79)	(–1.91)	(–1.97)
CusRet	–0.013**	–0.013**	–0.020	–0.020
	(–2.01)	(–2.01)	(–0.97)	(–1.01)
stdCusGro	–0.003	–0.003	0.113	0.116
	(−0.13)	(−0.14)	(1.14)	(1.19)
Change	–0.003	–0.003	–0.042*	–0.041*
	(–0.82)	(–0.68)	(–1.77)	(–1.74)
*Big*4	–0.003	–0.002	0.228*	0.229**
	(–0.15)	(–0.11)	(1.96)	(2.00)
ComAud	–0.012	–0.012	–0.001	–0.008
	(–0.95)	(–1.01)	(–0.01)	(–0.09)
MKT	0.019	0.018	0.094**	0.090**
	(1.22)	(1.15)	(2.26)	(2.16)
Constant	1.221***	1.222***	4.437***	4.402***
	(3.27)	(3.29)	(3.92)	(3.94)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,419	1,419	1,269	1,269
Adj. R^2	0.271	0.272	0.257	0.260

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4.3.3. Excluding samples from 2019 and 2020

The COVID-19 outbreak may have had a negative impact on firms' production, business conditions and auditing. Thus, we excluded the 2019 and 2020 samples to test robustness. The regression results in Columns (3) and (4) of Table 5 show that the coefficients of *CusDigit* on *Lnfee* remain negative and significant, at least at the 5 % level, further confirming the robustness of our findings.

4.3.4. Controlling the impact of sticky audit fees

As audit fees are sticky, we used two methods to control for their possible impact on the findings. First, the previous year's audit fee ($Lnfee_{t-1}$) was added to the control variables for robustness testing. Second, Using the one-period lead of the dependent variable as the dependent variable ($Lnfee_{t+1}$). The regression results in Table 6 indicate that when controlling for $Lnfee_{t-1}$ in Columns (1) and (2), the coefficients of *CusDigit* on *Lnfee* remain negative and significant, at least at the 5 % level. Columns (3) and (4) show that the coefficients of *CusDigit* on $Lnfee_{t+1}$ remain negative and significant, at least at the 5 % level.

4.4. Endogeneity

4.4.1. Instrumental variable regression

Potential reverse causation between customer digital transformation and supplier audit fees is a concern. Lower audit fees may indicate a decrease in a supplier's operational risk and an improvement in financial statement quality. This could potentially attract customers with higher levels of digitization. To address this concern, we used the two-stage least squares (2SLS) statistical method to mitigate endogeneity issues. To proxy for customer digital transformation (*CusDigit*), two instrumental variables were selected based on previous studies (Di et al., 2020; Zhao et al., 2022). The first instrumental variable, *Dige*, combines the number of post offices per 10,000 people and the number of Internet users in the country in 1984 for each city. The second instrumental variable, *CusDigit_Peer*, represents the mean customer digital transformation of other suppliers in the same region and year. These instrumental variables were chosen because post offices have historically served as the primary communication infrastructure in China, influencing regional communication capacity and digitalization. In addition, the role of traditional postal communication has declined as technology has developed, reducing its impact on supplier audit costs and thus meeting the exclusivity requirement of instrumental variables. Additionally, customers within the same region share similar market environments, making their digital transformation decisions relevant, whereas the digitization level of other customers does not directly affect suppliers' audit fees.

The findings in Table 7 regarding the first-stage regression of the instrumental variables indicate a positive relationship between *Dige*/*CusDigit_Peer* and*CusDigit* significant at the 1 % level. This suggests a satisfactory correlation between the variables. Table 7 presents the results of the second-stage regression of the instrumental variables. The results of the weak instrument test are greater than 10 and the Hansen J statistic does not pass the significance test, which indicates that the instrumental variables we selected are appropriate. Consequently, the second-stage regression results show a negative relationship between *CusDigit* and the instrumental variables significant at the 1 % level. These findings suggest that reverse causality has a minimal effect on the influence of customers' digital transformation on suppliers' audit fees.

4.4.2. Entropy balancing method

Multiple linear regression enables the identification of causal effects by controlling for observable confounding variables. However, the functional form must be correctly specified to avoid capturing residual terms and introducing endogeneity issues. To mitigate this concern, we used the entropy balancing (EB) method suggested by Hainmueller (2012) to address potential endogeneity problems arising from misspecifications in the regression model. EB adjusts the observed values of the control group by assigning optimal weights, thus enhancing the similarity in covariates between the control and treatment groups.

The EB method also minimizes the higher-order moment gaps of all control variables, based primarily on the level of customer digital transformation (grouped according to the annual median of *CusDigit*).The descriptive statistics after EB are presented in Table 8. By applying EB weights, we minimized the differences between the treatment ($CusDigit\_Dum = 1$) and control ($CusDigit\_Dum = 0$) groups in terms of first-, second-

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Table 6
Robustness test: Controlling for the impact of sticky audit fees.

Variable	(1) *Lnfee*	(2) *Lnfee*	(3) $Lnfee_{t+1}$	(4) $Lnfee_{t+1}$
*CusDigit*1	–0.948**		–1.877**	
	(–2.54)		(–2.32)	
*CusDigit*2		–0.022**		–0.034**
		(–2.03)		(–1.97)
$Lnfee_{t-1}$	0.255***	0.254***		
	(5.77)	(5.74)		
Size	0.256***	0.255***	0.460***	0.459***
	(6.56)	(6.49)	(3.18)	(3.19)
Lev	0.019	0.017	–0.265	–0.271
	(0.14)	(0.12)	(–0.60)	(–0.61)
CF	0.239*	0.227*	–0.351	–0.373
	(1.94)	(1.84)	(–0.67)	(–0.71)
Current	–0.012***	–0.012***	–0.009	–0.008
	(–2.92)	(–2.90)	(–1.14)	(–1.12)
ROA	0.071	0.066	0.407	0.394
	(0.28)	(0.26)	(0.68)	(0.66)
Receiv	0.176	0.178	0.053	0.056
	(0.72)	(0.72)	(0.07)	(0.08)
Loss	0.059	0.057	0.077	0.074
	(1.44)	(1.39)	(1.28)	(1.22)
Age	7.682***	7.631***	–6.687	–6.790
	(5.46)	(5.29)	(–0.36)	(–0.36)
BusSeg	–0.002	–0.002	–0.004	–0.004
	(–0.19)	(–0.19)	(–0.37)	(–0.37)
Digit	0.005	0.001	–0.475	–0.488
	(0.02)	(0.00)	(–1.18)	(–1.20)
Board	0.200*	0.193*	0.080	0.063
	(1.75)	(1.68)	(0.38)	(0.30)
Indrt	0.094	0.076	1.660	1.612
	(0.29)	(0.24)	(1.26)	(1.23)
Sep	–0.001	–0.001	0.001	0.001
	(–0.36)	(–0.40)	(0.19)	(0.14)
SOE	0.158	0.152	–0.039	–0.051
	(1.57)	(1.46)	(–0.31)	(–0.40)
CC	–0.003*	–0.003*	0.000	0.000
	(–1.94)	(–1.84)	(0.12)	(0.18)
CusRet	–0.008	–0.009	–0.098	–0.100
	(–0.45)	(–0.47)	(–1.06)	(–1.08)
stdCusGro	0.116	0.111	–0.198	–0.211
	(1.22)	(1.18)	(–0.83)	(–0.87)
Change	–0.038	–0.037	–0.013	–0.010
	(–1.63)	(–1.56)	(–0.13)	(–0.10)
*Big*4	0.285***	0.287***	0.253	0.258*
	(3.08)	(3.15)	(1.60)	(1.65)
ComAud	0.101	0.101	0.022	0.022
	(1.42)	(1.40)	(0.16)	(0.16)
MKT	0.113***	0.111***	–0.055	–0.057
	(2.67)	(2.61)	(–0.51)	(–0.53)
Constant	2.747**	2.816***	3.993	4.106
	(2.57)	(2.63)	(1.02)	(1.05)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,347	1,347	1,419	1,419
Adj. R^2	0.293	0.291	0.016	0.015

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Table 7
Endogeneity: Instrumental variable analysis.

Variable	(1) *CusDigit*1	(2) *CusDigit*2	(3) *Lnfee*	(4) *Lnfee*
Dige	0.001***	0.034***		
	(2.88)	(3.59)		
CusDigit_Peer	0.005***	0.211***		
	(3.09)	(3.22)		
*CusDigit*1			–9.273***	
			(–2.97)	
*CusDigit*2				–0.213***
				(–3.30)
Size	0.004	0.201**	0.379***	0.381***
	(1.27)	(2.03)	(7.21)	(7.98)
Lev	0.005	0.129	–0.058	–0.081
	(0.61)	(0.40)	(–0.33)	(–0.45)
CF	0.016	0.251	0.498***	0.400**
	(1.18)	(0.53)	(2.69)	(2.33)
Current	–0.000	–0.004	–0.010*	–0.009*
	(–0.42)	(–0.23)	(–1.68)	(–1.71)
ROA	0.014	0.423	0.173	0.132
	(0.67)	(0.62)	(0.57)	(0.44)
Receiv	0.004	0.350	0.373	0.411
	(0.14)	(0.40)	(1.05)	(1.33)
Loss	–0.000	–0.106	0.082*	0.063
	(−0.13)	(−1.05)	(1.65)	(1.33)
Age	0.311	12.219	8.065***	7.817***
	(1.35)	(1.41)	(4.18)	(3.83)
BusSeg	–0.000	–0.020	–0.011	–0.012
	(–0.53)	(–0.87)	(–1.00)	(–1.18)
Digit	0.031	1.393	0.213	0.219
	(1.00)	(1.52)	(0.60)	(0.76)
Board	0.009	0.053	0.288*	0.216
	(0.97)	(0.17)	(1.95)	(1.53)
Indrt	0.048	1.210	0.693	0.510
	(1.34)	(0.93)	(1.39)	(1.17)
Sep	0.000	–0.004	0.000	–0.001
	(0.16)	(–0.51)	(0.08)	(–0.25)
SOE	0.010	0.228	0.313**	0.265**
	(0.87)	(0.66)	(2.53)	(2.22)
CC	–0.000*	–0.018**	–0.008***	–0.007***
	(–1.87)	(–2.40)	(–3.08)	(–3.60)
CusRet	0.003*	0.128*	–0.000	–0.003
	(1.75)	(1.73)	(–0.01)	(–0.12)
stdCusGro	0.011	0.326	0.287*	0.254*
	(0.85)	(0.67)	(1.82)	(1.85)
Change	–0.001	0.012	–0.041	–0.025
	(–0.86)	(0.18)	(–1.54)	(–0.98)
*Big*4	0.002	0.217	0.283**	0.311***
	(0.27)	(0.66)	(2.23)	(2.74)
ComAud	–0.000	–0.013	0.130	0.127
	(–0.01)	(–0.03)	(0.96)	(0.86)
MKT	–0.002	–0.196	0.118*	0.096
	(–0.46)	(–1.23)	(1.87)	(1.60)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

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Table 7 (*continued*)

Variable	(1) *CusDigit*1	(2) *CusDigit*2	(3) *Lnfee*	(4) *Lnfee*
N	1,419	1,419	1,419	1,419
Kleibergen–Paap rk Wald F			16.569	15.175
Hansen–J P value			0.486	0.436

Notes: Standard errors are clustered at the firm level. *statistically significant at the 10%, **statistically significant at the 5% and ***statistically significant at the 1% level. Z-statistics are given in parentheses.

and third-order moments. This reduction in the dependence on the functional form setting enabled our subsequent analysis. Table 9 displays the regression results based on entropy balanced samples, with regression weights calculated from all control variables presented in Columns (1) and (2). The regression results indicate negative coefficients for *CusDigit* significant at least at the 5 % level across all weight variations. This finding suggests that the endogeneity problem resulting from biased functional form specifications is minimal.

4.4.3. Excluding the effect of strategic disclosure

We took three approaches to address concerns about the accuracy of textual information disclosure when evaluating customer digital transformation. First, we used a financial indicator, the ratio of digitization-related intangible assets to total intangible assets in customers' financial statements, as proposed by Zhang et al. (2021), as an endogeneity test for customer digital transformation (referred to as *CusDigit_Intan*). Second, we followed the methodology of Li et al. (2022) and excluded customer firms with poor disclosure quality, including those penalized by regulatory bodies such as the U.S. Securities and Exchange Commission (SEC) or stock exchanges for disclosure-related issues. Finally, we omitted customer firms operating in the digitization industry from the sample.

Table 8
Endogeneity: EB descriptive statistics.

Variable	*CusDigit_Dum* = 1			*CusDigit_Dum* = 0		
	Mean_Tr	*Var_Tr*	*Skew_Tr*	*Mean_Co_Post*	*Var_Co_Post*	*Skew_Co_Post*
Size	21.78890	1.308296	0.562143	21.78613	1.308151	0.569496
Lev	0.401146	0.044788	0.219762	0.401096	0.044783	0.220499
CF	0.039810	0.004114	0.086055	0.039805	0.004114	0.086306
Current	2.972146	12.46674	3.549138	2.971747	12.46506	3.549703
ROA	0.042792	0.004424	–1.336220	0.042786	0.004423	–1.336040
Receiv	0.158129	0.014073	0.955495	0.158108	0.014071	0.956069
Loss	0.095528	0.086579	2.752036	0.095580	0.086538	2.751026
Age	0.163232	0.003298	0.223656	0.163211	0.003298	0.224762
BusSeg	0.894309	2.664978	2.017626	0.894191	2.664640	2.017977
Digit	0.045841	0.006354	2.226320	0.045834	0.006353	2.226701
Board	2.156997	0.033773	–0.44095	2.156723	0.033769	–0.436470
Indrt	0.370739	0.002474	1.466918	0.370692	0.002474	1.469896
Sep	5.033947	59.31967	1.341298	5.033343	59.31253	1.341623
SOE	0.363821	0.231927	0.566117	0.364068	0.231773	0.565008
CC	5.016167	65.66496	3.062957	5.015568	65.65821	3.063388
CusRet	0.138168	0.167075	1.326649	0.138151	0.167054	1.326868
stdCusGro	0.078922	0.008491	2.056275	0.078912	0.008490	2.056727
Change	0.130081	0.113391	2.199326	0.130243	0.113402	2.197206
Big4	0.012195	0.012071	8.888889	0.012212	0.012076	8.882332
ComAud	0.03252	0.031527	5.271016	0.032540	0.031515	5.269221
MKT	0.593496	0.241750	–0.380700	0.593295	0.241557	–0.379850

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Table 9
Endogeneity: EB method.

Variable	(1) *Lnfee*	(2) *Lnfee*
*CusDigit*1	–1.111***	
	(–2.61)	
*CusDigit*2		–0.026**
		(–2.26)
Size	0.313***	0.331***
	(6.64)	(6.45)
Lev	–0.031	–0.076
	(–0.18)	(–0.41)
CF	0.380**	0.437**
	(2.50)	(2.53)
Current	–0.007	–0.008*
	(–1.42)	(–1.71)
ROA	0.075	0.275
	(0.29)	(0.94)
Receiv	0.339	0.353
	(1.18)	(1.20)
Loss	0.065	0.086*
	(1.42)	(1.70)
Age	6.083	3.664
	(1.34)	(0.82)
BusSeg	–0.008	–0.010
	(–1.00)	(–1.33)
Digit	0.034	–0.031
	(0.12)	(–0.11)
Board	0.167	0.152
	(1.33)	(1.22)
Indrt	0.009	0.017
	(0.02)	(0.05)
Sep	0.001	–0.000
	(0.17)	(–0.15)
SOE	0.227**	0.201*
	(2.06)	(1.76)
CC	–0.004*	–0.004*
	(–1.87)	(–1.83)
CusRet	–0.014	–0.016
	(–0.75)	(–0.79)
stdCusGro	0.196*	0.170
	(1.68)	(1.40)
Change	–0.030	–0.026
	(–1.09)	(–0.88)
*Big*4	0.281***	0.291***
	(3.03)	(4.13)
ComAud	0.103**	0.122**
	(1.98)	(2.02)
MKT	0.143***	0.132**
	(2.61)	(2.34)
Constant	5.196***	5.265***
	(4.17)	(4.01)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1,419	1,419
Adj. R^2	0.254	0.276

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Table 10
Endogeneity: Excluding the effect of strategic disclosure.

Variable	(1) *Lnfee*	(2) *Lnfee*	(3) *Lnfee*	(4) *Lnfee*	(5) *Lnfee*
CusDigit_Intan	–0.053**				
	(–2.01)				
*CusDigit*1		–1.487***		–1.222***	
		(–2.85)		(–2.96)	
*CusDigit*2			–0.046***		–0.032***
			(–3.54)		(–2.63)
Size	0.341***	0.342***	0.347***	0.371***	0.373***
	(7.50)	(7.38)	(7.43)	(8.20)	(8.21)
Lev	–0.101	–0.206	–0.210	–0.188	–0.189
	(–0.62)	(–1.22)	(–1.23)	(–1.10)	(–1.09)
CF	0.327**	0.327**	0.327**	0.382***	0.363**
	(2.24)	(2.10)	(2.07)	(2.66)	(2.55)
Current	–0.009*	–0.008*	–0.008*	–0.006	–0.006
	(–1.87)	(–1.74)	(–1.68)	(–1.45)	(–1.45)
ROA	0.009	0.360	0.365	–0.005	0.000
	(0.03)	(1.23)	(1.21)	(–0.02)	(0.00)
Receiv	0.309	0.117	0.150	0.631**	0.640**
	(1.10)	(0.40)	(0.51)	(2.06)	(2.08)
Loss	0.077*	0.079**	0.077**	0.075*	0.073*
	(1.84)	(2.12)	(2.09)	(1.72)	(1.67)
Age	6.392***	2.190	2.205	11.143***	11.111***
	(4.00)	(1.48)	(1.45)	(3.44)	(3.46)
BusSeg	–0.006	–0.009	–0.010	–0.005	–0.005
	(–0.63)	(–1.02)	(–1.12)	(–0.52)	(–0.54)
Digit	–0.119	0.110	0.158	–0.140	–0.144
	(–0.45)	(0.40)	(0.58)	(–0.51)	(–0.51)
Board	0.170	0.334***	0.329***	0.121	0.114
	(1.41)	(2.75)	(2.69)	(1.01)	(0.95)
Indrt	0.220	0.633*	0.608*	–0.018	–0.003
	(0.65)	(1.91)	(1.90)	(–0.05)	(–0.01)
Sep	–0.000	–0.000	–0.000	0.001	0.001
	(–0.10)	(–0.03)	(–0.12)	(0.21)	(0.20)
SOE	0.199*	0.320***	0.319***	0.272**	0.271**
	(1.66)	(2.80)	(2.78)	(2.49)	(2.45)
CC	–0.004**	–0.003**	–0.003**	–0.005***	–0.005***
	(–2.31)	(–2.04)	(–2.18)	(–2.67)	(–2.64)
CusRet	–0.028	–0.022	–0.020	–0.035	–0.034
	(–1.38)	(–1.15)	(–1.10)	(–1.60)	(–1.55)
stdCusGro	0.112	0.168*	0.167*	0.194**	0.185*
	(1.17)	(1.70)	(1.73)	(2.04)	(1.95)
Change	–0.031	–0.044**	–0.042*	–0.040	–0.037
	(–1.34)	(–1.96)	(–1.90)	(–1.58)	(–1.48)
*Big*4	0.304***	0.296***	0.301***	0.304***	0.310***
	(3.08)	(3.02)	(3.23)	(3.34)	(3.43)
ComAud	0.146	0.019	0.014	0.139	0.135
	(1.60)	(0.20)	(0.14)	(1.12)	(1.04)
MKT	0.138***	0.115**	0.107**	0.108***	0.105***
	(3.10)	(2.49)	(2.28)	(2.76)	(2.65)
Constant	4.531***	4.631***	4.572***	3.310***	3.286***
	(4.16)	(4.34)	(4.26)	(3.50)	(3.49)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	1,419	1,166	1,166	1,266	1,266
Adj. R^2	0.236	0.266	0.271	0.266	0.266

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The results in Column (1) of Table 10 indicate that *CusDigit_Intan* has a statistically significant impact on reducing suppliers' audit fees at the 5 % level. To further validate these findings, we excluded samples with disclosure violations and find negative regression coefficients for *CusDigit*1 and *CusDigit*2 on suppliers' audit fees in Columns (2) and (3), significant at the 1 % level. Likewise, in Columns (4) and (5), we exclude digitization-related industries and find negative regression coefficients for *CusDigit*1 and *CusDigit*2 on suppliers' audit fees, significant at the 1 % level. These results address concerns about potential noise in the disclosure of customer digital transformation, thereby reinforcing the reliability of our conclusions.

4.4.4. Heckman two-stage test

We identified two potential issues related to self-selection. First, lower audit fees may indicate suppliers with more reliable financial statements and lower business risk. Such suppliers may deliberately choose to collaborate with customers that have higher growth prospects and invest more in digital transformation. This selection process may introduce bias into our study. The second issue relates to the costs associated with disclosing important customer information. The CSRC only encourages listed companies to disclose details about their top five customers, rather than making it mandatory. Suppliers' disclosure of customer information is thus voluntary, which introduces another self-selection issue into the sample. We addressed these concerns using the Heckman two-stage test.

To address the first type of self-selection problem, we used a two-stage regression approach. In the first stage, we conducted a logit regression, in which the dependent variable (*CusDigit_Dum*) was regressed on the control and instrumental variables (*Dige*).[2] The Inverse Mills Ratio (*IMR*1) was estimated using the regression. In the second stage, the estimated *IMR*1 was incorporated into Model (1) for further regression analysis. The regression results in Columns (2) and (3) of Table 11 demonstrate a statistically significant negative relationship between *CusDigit* and *Lnfee*.

We used a logit regression in the first stage to address the second type of self-selection issue (Di et al., 2020). The dependent variable in this regression was whether the supplier discloses customer information in the current year (*DiscloCus*) and the instrumental variable was the mean disclosure status of other suppliers in the same region and year (*mean_DiscloCus*). In the second stage, we incorporated the estimated *IMR*2 into regression Model (1). Columns (2) and (3) of Table 12 reveal a significant negative relationship between *CusDigit* and *Lnfee*. The findings in Tables 11 and 12 indicate that the results remain robust when considering self-selection issues.

5. Additional tests

5.1. Mechanisms analysis

5.1.1. Audit risk

Operational risk and earnings management can potentially increase audit risks and audit fees (Shimnitsch, 1980; Defond and Lennox, 2011). We propose that customers' digital transformation helps to reduce suppliers' audit costs by reducing their audit risks. Digital transformation can enhance customers' information transparency and decrease their operational risks (Zhang et al., 2021), thus alleviating the operational risks that can spill over to suppliers through the supply chain. This digital transformation also reduces suppliers' incentives to manipulate earnings, as it empowers customers to respond better to risks, encourages information transparency and facilitates efficient collaboration throughout the supply chain. This reduces the volatility of supplier performance and the motivation of management to manipulate earnings and financial statements, ultimately enhancing the quality of these firms' accounting information. Customers' digital transformation therefore mitigates suppliers' operational risks and earnings manipulation, leading to a reduction in auditors' perceptions of risk and thus suppliers' audit fees.

[2] *Dige* represents the number of post offices per 10,000 people and the number of Internet users in the country in 1984 for each city.

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Table 11
Endogeneity: Heckman two-stage test- The self-selection problem for customer digital transformation.

Variable	(1) *CusDigit1_Dum*	(2) *Lnfee*	(3) *Lnfee*
Dige	0.136***		
	(2.96)		
CusDigit1		–1.048**	
		(–2.58)	
CusDigit2			–0.027**
			(–2.44)
IMR1		–0.001	–0.001
		(–1.02)	(–0.86)
Size	0.967*	0.345***	0.345***
	(1.81)	(7.64)	(7.62)
Lev	1.670	–0.101	–0.103
	(0.95)	(–0.62)	(–0.63)
CF	1.919	0.360**	0.350**
	(0.73)	(2.45)	(2.39)
Current	–0.045	–0.009**	–0.009**
	(–0.41)	(–1.99)	(–1.97)
ROA	3.429	0.038	0.032
	(0.82)	(0.14)	(0.12)
Receiv	3.756	0.319	0.324
	(1.11)	(1.15)	(1.16)
Loss	–0.724	0.079*	0.077*
	(–1.05)	(1.89)	(1.83)
Age	–3.818	6.109***	6.196***
	(–0.03)	(3.52)	(3.53)
BusSeg	–0.296**	–0.006	–0.006
	(–2.38)	(–0.65)	(–0.67)
Digit	1.209	–0.101	–0.095
	(0.26)	(–0.40)	(–0.37)
Board	–0.233	0.187	0.180
	(–0.11)	(1.54)	(1.47)
Indrt	–1.883	0.300	0.283
	(–0.32)	(0.87)	(0.83)
Sep	0.028	–0.000	–0.000
	(0.47)	(–0.09)	(–0.13)
SOE	1.669	0.226*	0.221*
	(1.19)	(1.93)	(1.85)
CC	–0.060*	–0.005***	–0.005***
	(–1.91)	(–2.63)	(–2.63)
CusRet	0.439	–0.021	–0.022
	(1.15)	(–1.08)	(–1.10)
stdCusGro	1.633	0.132	0.130
	(1.01)	(1.39)	(1.38)
Change	0.966***	–0.030	–0.028
	(2.58)	(–1.28)	(–1.21)
Big4	–0.503	0.295***	0.299***
	(–0.35)	(3.01)	(3.09)
ComAud	–1.119	0.138	0.137
	(–0.84)	(1.51)	(1.47)
MKT	–2.615**	0.126***	0.124***
	(–2.38)	(2.87)	(2.81)
Constant		4.420***	4.432***
		(4.04)	(4.07)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

(*continued on next page*)

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Table 11 (*continued*)

Variable	(1) *CusDigit*1_*Dum*	(2) *Lnfee*	(3) *Lnfee*
N	466	1,419	1,419
Adj. R^2	0.249	0.240	0.239

Notes: To ensure consistency in the full text model, xtlogit, which controls for firm-level fixed effects, is chosen for the first-stage regression, resulting in a sample size that differs from the benchmark regression (1,419), but this does not affect the results of the second-stage regression.

We tested this mechanism by measuring supplier firms' business risk (*Risk*) by the volatility of return on assets and used the modified Jones model to assess earnings management (*AbsDA*) (Dechow et al., 1995; Dou et al., 2019). Table 13 presents the mechanism analysis, indicating that the coefficients of *CusDigit* on *Risk* and *AbsDA* are statistically significant, with a negative value of at least 10 %. This suggests that digital transformation can mitigate suppliers' audit risks.

5.1.2. Audit cost

Auditors tasked with high-risk audit projects must implement more procedures and incur higher costs to maintain acceptable levels of audit risk (Zhang et al., 2021). The digital transformation of customers mitigates the operational risks faced by suppliers and discourages earnings management behavior, thereby ensuring the accuracy and reliability of suppliers' financial information and subsequently reducing their audit risks. This reduces the workload of auditors, leading to decreased audit costs and fees. To evaluate this mechanism, we followed previous research (Ashton et al., 1989) and used the audit reporting time lag (*AudLag*) as a proxy for audit input. *AudLag* represents the number of calendar days between the balance sheet date and the date on which a certified public accountant (CPA) signed the audit report. Table 14 shows a negative regression coefficient of *CusDigit* on *AudLag* significant at least at the 5 % level. This indicates that customers' digital transformation has a positive spillover effect on the supply chain, resulting in reduced audit costs.

5.2. Heterogeneity analysis

5.2.1. Supply chain geographic distance

The proximity between stakeholders can lead to reduced information-gathering costs, address information asymmetry and enhance monitoring efficiency (Chu et al., 2019). Digital transformation can also overcome spatial barriers and facilitate swift data exchange and collaboration (Li et al., 2022). As customers undergo digital transformation, they encourage information collaboration within the supply chain, thereby alleviating information asymmetry and the communication challenges caused by significant geographic distance. Thus, we argue that a greater geographic distance within the supply chain leads to a more evident spillover effect from customer-driven digital transformation on suppliers. This effect enables suppliers to promptly acquire and comprehend customer information, leading to the more rational management of production and operational activities, improved operational efficiency and enhanced information quality in financial statements. Ultimately, these outcomes reduce audit costs. In this study, we define supply chain geographic distance (*Distance*) as the distance between each customer's location and that of the supplier company (in terms of latitude and longitude), weighted by the percentage of customer sales. We performed a heterogeneity analysis by cross-multiplying the independent variables by supply chain geographic distance (*CusDigit* × *Distance*). Table 15 shows that the regression coefficient of this cross-multiplication term is negative and significant at the 1 % level. This finding suggests that customers' digital transformation compensates for the challenges associated with accessing information arising from geographic distance, thus enabling suppliers to make timely adjustments to their business decisions and mitigate operational volatility. This consequently reduces the audit risk premium and costs.

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Table 12
Endogeneity: Heckman two-stage test- The self-selection problem in corporate disclosure of customer information.

Variable	(1) *DisclosCus*	(2) *Lnfee*	(3) *Lnfee*
mean_DisclosCus	2.745***		
	(5.57)		
*CusDigit*1		–1.142***	
		(–2.78)	
*CusDigit*2			–0.030***
			(–2.71)
*IMR*2		0.021	0.024
		(0.43)	(0.48)
Size	–0.557***	0.332***	0.331***
	(–6.54)	(7.36)	(7.28)
Lev	0.368	–0.093	–0.095
	(1.06)	(–0.57)	(–0.57)
CF	–1.116**	0.339**	0.325**
	(–2.21)	(2.37)	(2.26)
Current	0.005	–0.008*	–0.008*
	(0.27)	(–1.89)	(–1.88)
ROA	0.023	0.018	0.015
	(0.03)	(0.07)	(0.06)
Receiv	–1.513***	0.282	0.285
	(–2.59)	(0.99)	(0.99)
Loss	–0.188	0.076*	0.073*
	(–1.45)	(1.84)	(1.75)
Age	0.380*	7.577***	7.665***
	(1.78)	(2.98)	(2.99)
BusSeg	–0.025	–0.006	–0.007
	(–1.09)	(–0.70)	(–0.74)
Digit	–4.873***	–0.219	–0.225
	(–4.57)	(–0.54)	(–0.55)
Board	0.062	0.188	0.180
	(0.17)	(1.56)	(1.48)
Indrt	–1.558	0.257	0.235
	(–1.46)	(0.75)	(0.70)
Sep	0.001	–0.000	–0.000
	(0.16)	(–0.09)	(–0.13)
SOE	0.053	0.222*	0.217*
	(0.21)	(1.90)	(1.82)
CC	0.026***	–0.004*	–0.004*
	(5.36)	(–1.80)	(–1.78)
Change	–0.194**	–0.036	–0.034
	(–2.21)	(–1.47)	(–1.41)
*Big*4	0.019	0.303***	0.307***
	(0.06)	(3.05)	(3.14)
ComAud	16.125	0.486	0.525
	(0.01)	(0.59)	(0.63)
MKT	0.468***	0.143***	0.140***
	(3.51)	(3.09)	(3.02)
CusRet		–0.024	–0.024
		(–1.21)	(–1.22)
stdCusGro		0.130	0.128
		(1.35)	(1.35)
Constant		3.991**	3.962**
		(2.51)	(2.51)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

(*continued on next page*)

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Table 12 (*continued*)

Variable	(1) *DiscloCus*	(2) *Lnfee*	(3) *Lnfee*
N	10,420	1,419	1,419
Adj. R^2	0.369	0.239	0.239

Notes: The second type of self-selection problem considers the fact that listed firms in China selectively disclose customer information, which can lead to a restricted research sample in this paper that does not fully observe the customers of listed firms. To address this type of self-selection problem, the *DiscloCus* variable in the first stage measures whether or not all A-share listed firms in China disclose their customers, and this is used to estimate the inverse Mills ratio. This results in a difference between the first stage regression sample and the benchmark regression.

5.2.2. Specialization investment intensity

Supply chain-specific investments are irreversible, and thus their value is closely tied to customers' survival cycles and growth prospects. Stable relationships with customers lead to a higher likelihood of achieving a higher return on investment. However, if these relationships are severed, suppliers may incur significant costs when attempting to find replacements (Raman and Shahrur, 2008). Suppliers who make substantial investments that are specific to the supply chain are susceptible to a major risk known as "lock-in." Customers demand lower prices or extended credit terms, which affect firms' profits (Gosman et al., 2004). Suppliers then feel compelled to increase their accounts receivable and inventory levels, which in turn increases their operational and financial risks. This escalation also leads to higher audit costs and risks for auditors. We argue that as customers undergo digital transformation, the mitigating effect on suppliers' operational risks becomes more pronounced with higher levels of supply chain-specific investments. This in turn influences suppliers' audit costs.

To support our argument, we followed Raman and Shahrur (2008) and defined supply chain specialization investment as the ratio of suppliers' R&D investments to their total assets in the preceding year. We then established a dummy variable, supply chain-specific investment intensity (*SpeInv*), based on the median value of annual supply chain specialization investment. We assigned *SpeInv* a value of 1 for supply chain specialization investment that exceeds the annual median value and 0 otherwise. Table 16 shows that the regression coefficient of the interaction term (*CusDigit* × *SpeInv*) is negative and significant at least at the 5 % level. This implies that as suppliers increase their supply chain-specific investments, their economic relationship with their customers strengthens, enhancing the effect of customer risk mitigation on the value of the supply chain relationship. The reduction in supplier audit costs resulting from customer digital transformation is thus greater when suppliers invest more in supply chain-specific relationships.

5.2.3. Supplier market competition

A firm's bargaining power can help to shape and influence the dynamics of its relationships in the supply chain (Dhaliwal et al., 2016). When faced with intense market competition, customers often gain power, enabling them to switch to suppliers who offer lower prices and more favorable credit terms. However, the severing of ties can impose significant costs on suppliers and potential loss of revenue, forcing them to choose between compromising on profits or investing more in maintaining stable relationships (Gosman et al., 2004). This vulnerability exposes suppliers to economic pressure from key customers and to disruption in competitive markets, thereby increasing their business risks. We argue that the digital transformation of their customers can alleviate their business risks through the spillover effect, particularly in highly competitive markets. Consequently, the impact on suppliers' audit fees of their customers' digital transformation is magnified in competitive market environments.

We addressed this using the Herfindahl index to assess suppliers' bargaining power, by examining their market share of sales revenue within the industry for the same year. We established a binary variable representing supplier market competition (*HHI*) based on the annual median of the Herfindahl index. *HHI* was assigned a value of 1 when the Herfindahl index is less than or equal to the annual median and 0 otherwise. A lower Herfindahl index indicates a higher level of market competition among suppliers. The regression results in Table 17 demonstrate a negative coefficient for the cross-multiplier term of customer digital trans-

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Table 13
Mechanisms analysis: Audit risk.

Variable	(1) *Risk*	(2) *Risk*	(3) *AbsDA*	(4) *AbsDA*
*CusDigit*1	–0.478**		–0.170*	
	(–2.13)		(–1.86)	
*CusDigit*2		–0.013**		–0.004*
		(–2.18)		(–1.68)
Size	–0.003	–0.003	0.002	0.002
	(–0.19)	(–0.16)	(0.33)	(0.35)
Lev	0.004	0.003	–0.022	–0.023
	(0.10)	(0.07)	(–0.87)	(–0.88)
CF	0.012	0.007	–0.283***	–0.285***
	(0.16)	(0.10)	(–5.73)	(–5.77)
Current	–0.001	–0.001	–0.002	–0.002
	(–0.54)	(–0.52)	(–1.44)	(–1.43)
ROA	0.054	0.052	0.034	0.034
	(0.65)	(0.63)	(0.45)	(0.45)
Receiv	–0.150	–0.148	0.065	0.066
	(–1.36)	(–1.34)	(0.97)	(0.98)
Loss	0.032***	0.031***	0.009	0.008
	(2.89)	(2.81)	(1.12)	(1.06)
Age	0.323	0.319	1.789***	1.787***
	(0.58)	(0.57)	(5.35)	(5.40)
BusSeg	–0.004	–0.004	–0.001	–0.001
	(–1.54)	(–1.57)	(–0.33)	(–0.35)
Digit	0.039	0.042	–0.008	–0.007
	(0.20)	(0.22)	(–0.13)	(–0.12)
Board	–0.068	–0.072	0.020	0.019
	(–1.13)	(–1.19)	(0.79)	(0.74)
Indrt	0.040	0.032	–0.007	–0.010
	(0.26)	(0.22)	(–0.09)	(–0.12)
Sep	–0.000	–0.000	–0.000	–0.001
	(–0.27)	(–0.40)	(–1.00)	(–1.05)
SOE	–0.002	–0.004	–0.010	–0.011
	(–0.11)	(–0.23)	(–0.57)	(–0.61)
CC	–0.001	–0.001	–0.000	–0.000
	(–0.80)	(–0.81)	(–0.84)	(–0.84)
CusRet	–0.003	–0.003	–0.004	–0.004
	(–0.33)	(–0.33)	(–0.63)	(–0.63)
stdCusGro	0.040	0.039	–0.012	–0.012
	(0.60)	(0.59)	(–0.48)	(–0.49)
Change	0.002	0.003	0.012**	0.012**
	(0.20)	(0.29)	(2.02)	(2.08)
*Big*4	0.044	0.046	–0.009	–0.008
	(0.78)	(0.80)	(–0.38)	(–0.36)
ComAud	0.089	0.089	–0.005	–0.005
	(1.08)	(1.08)	(–0.54)	(–0.56)
MKT	0.023	0.021	0.004	0.003
	(1.54)	(1.43)	(0.33)	(0.28)
Constant	0.207	0.214	–0.275	–0.273
	(0.64)	(0.67)	(–1.52)	(–1.50)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1,419	1,419	1,419	1,419
Adj. R^2	0.019	0.018	0.090	0.089

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Table 14
Mechanisms analysis: Audit cost.

Variable	(1) *AudLag*	(2) *AudLag*
*CusDigit*1	–1.122***	
	(–3.41)	
*CusDigit*2		–0.022**
		(–2.39)
Size	0.036	0.035
	(1.17)	(1.15)
Lev	0.011	0.008
	(0.12)	(0.08)
CF	–0.227	–0.239
	(–1.56)	(–1.64)
Current	–0.004	–0.004
	(–1.22)	(–1.18)
ROA	–0.157	–0.164
	(–0.76)	(–0.79)
Receiv	–0.095	–0.092
	(–0.52)	(–0.50)
Loss	0.042	0.040
	(1.28)	(1.21)
Age	6.122***	6.070***
	(2.98)	(2.89)
BusSeg	–0.000	–0.000
	(–0.03)	(–0.03)
Digit	–0.000	–0.006
	(–0.00)	(–0.03)
Board	–0.046	–0.055
	(–0.50)	(–0.60)
Indrt	0.091	0.064
	(0.28)	(0.20)
Sep	–0.001	–0.002
	(–0.68)	(–0.74)
SOE	0.036	0.029
	(0.61)	(0.47)
CC	–0.003**	–0.003**
	(–2.06)	(–2.04)
CusRet	0.014	0.014
	(0.75)	(0.71)
stdCusGro	0.110	0.103
	(1.16)	(1.09)
Change	0.023	0.025
	(1.17)	(1.26)
*Big*4	0.140	0.143
	(1.25)	(1.28)
ComAud	–0.118*	–0.118*
	(–1.80)	(–1.77)
MKT	0.005	0.003
	(0.12)	(0.07)
Constant	–0.844	–0.785
	(–0.96)	(–0.89)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1,419	1,419
Adj. R^2	0.026	0.020

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Table 15
Heterogeneity analysis: Supply chain geographic distance.

Variable	(1) *Lnfee*	(2) *Lnfee*
*CusDigit*1	–0.910**	
	(–2.33)	
*CusDigit*1 × *Distance*	–0.563***	
	(–3.36)	
*CusDigit*2		–0.026**
		(–2.36)
*CusDigit*2 × *Distance*		–0.006***
		(–2.82)
Distance	0.003**	0.001
	(2.34)	(0.93)
Size	0.344***	0.344***
	(7.76)	(7.69)
Lev	–0.094	–0.098
	(–0.58)	(–0.59)
CF	0.368**	0.352**
	(2.53)	(2.42)
Current	–0.008*	–0.008*
	(–1.78)	(–1.79)
ROA	0.013	0.017
	(0.05)	(0.06)
Receiv	0.318	0.321
	(1.16)	(1.16)
Loss	0.079*	0.078*
	(1.89)	(1.85)
Age	6.779***	6.745***
	(4.24)	(4.11)
BusSeg	–0.007	–0.007
	(–0.75)	(–0.73)
Digit	–0.102	–0.091
	(–0.40)	(–0.36)
Board	0.187	0.179
	(1.53)	(1.46)
Indrt	0.281	0.272
	(0.81)	(0.79)
Sep	–0.000	–0.000
	(–0.10)	(–0.14)
SOE	0.219*	0.216*
	(1.85)	(1.80)
CC	–0.005***	–0.005***
	(–2.79)	(–2.75)
CusRet	–0.022	–0.023
	(–1.14)	(–1.17)
stdCusGro	0.125	0.125
	(1.31)	(1.32)
Change	–0.030	–0.028
	(–1.28)	(–1.21)
*Big*4	0.301***	0.302***
	(3.06)	(3.13)
ComAud	0.149*	0.155*
	(1.71)	(1.70)
MKT	0.133***	0.130***
	(3.07)	(2.95)
Constant	4.350***	4.390***
	(4.04)	(4.06)

(*continued on next page*)

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Table 15 (*continued*)

Variable	(1) *Lnfee*	(2) *Lnfee*
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1,419	1,419
Adj. R^2	0.243	0.240

Table 16
Heterogeneity analysis: Suppliers' specialization investment intensity.

Variable	(1) *Lnfee*	(2) *Lnfee*
*CusDigit*1	–0.247	
	(–0.49)	
*CusDigit*1 × *SpeInv*	–1.545***	
	(–2.66)	
*CusDigit*2		–0.006
		(–0.43)
*CusDigit*2 × *SpeInv*		–0.050***
		(–3.25)
SpeInv	0.028	0.040
	(1.15)	(1.63)
Size	0.348***	0.351***
	(7.74)	(7.86)
Lev	–0.107	–0.116
	(–0.65)	(–0.70)
CF	0.367**	0.366**
	(2.51)	(2.50)
Current	–0.008*	–0.008*
	(–1.89)	(–1.79)
ROA	–0.024	–0.038
	(–0.09)	(–0.14)
Receiv	0.314	0.324
	(1.13)	(1.18)
Loss	0.077*	0.075*
	(1.84)	(1.81)
Age	7.482***	7.839***
	(4.50)	(4.66)
BusSeg	–0.006	–0.006
	(–0.69)	(–0.70)
Digit	–0.068	–0.061
	(–0.27)	(–0.24)
Board	0.194	0.181
	(1.59)	(1.48)
Indrt	0.276	0.254
	(0.80)	(0.74)
Sep	–0.000	–0.000
	(–0.05)	(–0.05)
SOE	0.205*	0.203*
	(1.70)	(1.70)
CC	–0.005***	–0.005***
	(–2.60)	(–2.63)
CusRet	–0.024	–0.025
	(–1.21)	(–1.26)

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Table 16 (*continued*)

Variable	(1) *Lnfee*	(2) *Lnfee*
stdCusGro	0.122	0.125
	(1.27)	(1.33)
Change	–0.031	–0.029
	(–1.35)	(–1.26)
Big4	0.304***	0.305***
	(3.00)	(3.05)
ComAud	0.136	0.134
	(1.52)	(1.50)
MKT	0.130***	0.123***
	(2.96)	(2.80)
Constant	4.135***	4.070***
	(3.78)	(3.73)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1,419	1,419
Adj. R^2	0.243	0.248

Table 17
Heterogeneity analysis: Supplier market competition.

Variable	(1) *Lnfee*	(2) *Lnfee*
CusDigit1	0.504	
	(0.65)	
CusDigit1 × *HHI*	–1.867**	
	(–2.24)	
CusDigit2		0.014
		(0.54)
CusDigit2 × *HHI*		–0.056**
		(–2.06)
HHI	0.046	0.062
	(1.06)	(1.43)
Size	0.343***	0.342***
	(7.74)	(7.84)
Lev	–0.089	–0.088
	(–0.55)	(–0.55)
CF	0.383***	0.378**
	(2.62)	(2.58)
Current	–0.008*	–0.008*
	(–1.79)	(–1.76)
ROA	0.039	0.068
	(0.14)	(0.25)
Receiv	0.324	0.333
	(1.17)	(1.20)
Loss	0.082*	0.082*
	(1.96)	(1.96)
Age	6.579***	6.460***
	(4.18)	(4.08)
BusSeg	–0.006	–0.006
	(–0.63)	(–0.68)
Digit	–0.071	–0.027
	(–0.28)	(–0.11)

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Table 17 (*continued*)

Variable	(1) *Lnfee*	(2) *Lnfee*
Board	0.190	0.181
	(1.57)	(1.51)
Indrt	0.283	0.240
	(0.81)	(0.71)
Sep	–0.001	–0.001
	(–0.19)	(–0.26)
SOE	0.233**	0.226**
	(2.05)	(1.96)
CC	–0.005***	–0.005***
	(–2.65)	(–2.84)
CusRet	–0.023	–0.021
	(–1.14)	(–1.06)
stdCusGro	0.147	0.146
	(1.54)	(1.55)
Change	–0.032	–0.032
	(–1.39)	(–1.38)
*Big*4	0.280***	0.276***
	(2.70)	(2.68)
ComAud	0.137	0.134
	(1.56)	(1.54)
MKT	0.136***	0.136***
	(3.08)	(3.09)
Constant	4.345***	4.417***
	(4.03)	(4.16)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1,419	1,419
Adj. R^2	0.242	0.245

formation and supplier market competitiveness dummy variables (*CusDigit* × *HHI*) significant at the 5 % level. This implies that the ability of customers' digital transformation to reduce suppliers' audit fees is greater in markets characterized by intense supplier competition.

6. Conclusion and discussion

Amid increased economic uncertainty, businesses are increasingly turning to digital transformation to enhance their resilience and optimize their resource allocation. The supply chain is a critical component of business operations that integrates logistics, information flow and capital flow. Microenterprises aiming to gain a competitive advantage can enhance their collaborations within supply chains. We investigated the spillover effect of customer digital transformation on suppliers through assessing its impact on audit fees. This extends research on the economic consequences of digital transformation beyond the boundaries of supply chain relationships. Our empirical findings indicate that customers' digital transformation can reduce suppliers' audit fees. Our heterogeneity analysis shows that this effect is more evident when there is a greater geographic distance between suppliers and customers, higher levels of dedicated investment and increased competitiveness in the supplier market. Through the economic mechanism of mitigating supply chain risk and facilitating collaboration and information transfer in supply chains, customers' digital transformation reduces suppliers' audit risks and costs, thus leading to lower audit fees.

Based on previous research findings, we offer the following conclusions. First, the implementation of digital transformation by suppliers' customers can potentially cause a spillover effect across the supply chain, thereby affecting the economic interests and decisions of suppliers. Consequently, when faced with fierce market competition, firms should fully realize the beneficial effects of digital transformation on information transfer effi-

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ciency and collaboration within the supply chain. Such transformation should therefore be actively promoted, because through it firms can facilitate a seamless connection of resources, information and knowledge within the supply chain, thus fostering sustainable economic growth through enhanced coordination and cooperation.

Second, in the audit context, customer digital transformation can help to bridge geographic information gaps and enhance the exchange of information between customers and suppliers. It can also enhance the efficiency of suppliers' decision-making and risk management, thereby reducing uncertainties and income fluctuations and ultimately mitigating audit risks. Audit firms should recognize the spillover effect of digital technologies on the supply chain. They can then conduct comprehensive risk assessments involving all relevant stakeholders and develop and implement effective audit protocols to minimize audit risks and safeguard investors' legitimate rights and interests. Additionally, to align themselves with current technological developments, audit practices should focus on big data and a value-added approach and should consistently promote the digital transformation of audit processes. This is critical for the dynamic evaluation of corporate financial statement quality, which can then increase audit efficiency.

Third, in terms of policy regulation, the government should take a broad approach but also customize interventions based on the specific needs of firms and offer digital transformation initiatives. By closely monitoring and supporting supply chains, the government can encourage customers with significant power within the supply chain to embark on digital initiatives, while also assisting in the integration of digital technologies throughout the supply chain. This involves facilitating the transformation of procurement, R&D, production, transportation and other related processes to increase the efficiency of supply chain management as a whole. However, the government should also endeavor to remove obstacles to firms' digital transformation. This includes addressing difficulties and barriers, improving the training and recruitment of digital professionals and providing financial and policy support for the research, development, application and dissemination of advanced technologies throughout the supply chain.

Declaration of competing interest

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

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