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Article

Digitalization, ESG-Oriented Innovation, and Corporate Resilience under Environmental Policy Shocks

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Abstract

This study examines how digitalization affects corporate resilience under environmental policy shocks in Chinese private manufacturing firms. We test whether ESG-oriented innovation mediates this relationship. Our panel dataset covers 3,870 firm-year observations from 2013 to 2022. Results show digitalization significantly enhances corporate resilience when environmental policies tighten. ESG-oriented innovation partially mediates this effect. The positive impact is stronger in large firms, state-owned enterprises, and foreign-invested companies. These findings suggest digitalization helps firms adapt to regulatory changes through sustainable innovation pathways. Our study contributes to understanding digital transformation's role in building organizational resilience. It also reveals the mechanisms through which firms navigate environmental policy uncertainties. The research offers practical implications for corporate strategy and policy design in emerging markets.

Keywords: Digitalization; ESG-oriented innovation; corporate resilience; environmental policy shocks

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1. Introduction

China's manufacturing sector faces unprecedented environmental regulatory pressures. The government has implemented stringent environmental policies since 2013. These policies create significant operational challenges for manufacturing firms. Private enterprises experience particularly acute pressures from compliance costs. Digital technologies offer potential solutions to these challenges. Firms increasingly adopt digital tools to improve operational efficiency. Environmental, Social, and Governance (ESG) principles have gained prominence in corporate strategy. The intersection of digitalization and ESG presents new research opportunities. Understanding how these factors interact under policy shocks remains critical. This study focuses on private manufacturing firms as they represent major employment and GDP contributors.

Why do some firms thrive under environmental policy shocks while others struggle? Existing literature suggests resource-based capabilities matter. However, digital transformation introduces new dynamics not fully explored. Traditional resilience studies focus on financial buffers or organizational slack. They overlook how digital capabilities reshape firm responses to external shocks. Environmental policies create compliance costs but also innovation opportunities. Firms must balance short-term survival with long-term sustainability.

ESG-oriented innovation represents a strategic response to these dual pressures. Yet the mechanisms linking digitalization to resilience remain unclear. Does digitalization directly enhance resilience, or does it work through innovation pathways? How do firm characteristics moderate these relationships? These questions motivate our investigation.

The research problem centers on three gaps. First, prior studies examine digitalization and resilience separately. Second, ESG innovation's mediating role lacks empirical testing. Third, heterogeneous effects across firm types need exploration. We address these gaps by analyzing large-scale panel data. Our study tests specific mechanisms through which digitalization operates. We also examine boundary conditions that strengthen or weaken these effects. Understanding these dynamics helps firms develop adaptive strategies. It also informs policymakers about differential impacts across enterprise types. The findings contribute to both academic knowledge and practical applications.

This study makes several contributions to existing literature. First, we establish digitalization as a key driver of corporate resilience under environmental shocks. Our results show a positive and significant relationship between digital adoption and firm resilience. Second, we identify ESG-oriented innovation as a mediating mechanism. Firms that invest in ESG innovation demonstrate stronger resilience outcomes. Moreover, the finding bridges digitalization and sustainability literature streams. Third, we document heterogeneous effects across firm characteristics. Large firms benefit more from digitalization than small firms. State-owned enterprises show stronger resilience responses than private firms. Foreign-invested companies also exhibit greater resilience improvements. These findings reveal important boundary conditions for digital strategies. Our study advances theoretical understanding of digital transformation's strategic value. It also provides empirical evidence for mechanism-based explanations of corporate resilience.

The remainder of this paper proceeds as follows. Section 2 reviews relevant literature and develops hypotheses. We examine theories related to digitalization, ESG innovation, and corporate resilience. Section 3 describes our research design, including data sources and variable measurements. We explain our empirical strategy for testing hypotheses. Section 4 presents empirical results from baseline regressions, heterogeneity analyses, and mechanism tests. Section 5 concludes with theoretical and practical implications. We discuss policy recommendations and future research directions

2. Materials and Methods

2.1 Theoretical Foundation

2.1.1 Dynamic Capabilities Theory

Dynamic capabilities theory explains how firms adapt to changing environments. Teece et al. (2016) define dynamic capabilities as the ability to sense, seize, and reconfigure resources. These capabilities enable firms to respond effectively to external shocks. Digitalization represents a key component of sensing capabilities. Digital tools provide real-time information about market and regulatory changes. They also enhance decision-making speed and accuracy. Firms with stronger dynamic capabilities demonstrate greater resilience under uncertainty. Environmental policy shocks require rapid organizational responses. Digital technologies facilitate these responses by enabling flexibility and adaptation. The theory suggests digitalization should enhance corporate resilience through improved sensing and seizing abilities. This theoretical lens guides our investigation of digitalization's effects on firm performance under environmental pressures. It predicts positive relationships between digital capabilities and resilience outcomes (Warner & Wäger, 2019).

2.1.2 Stakeholder Theory

Stakeholder theory posits that firms must balance multiple stakeholder interests. Freeman (2010) argues that sustainable value creation requires addressing stakeholder concerns.

Environmental policies reflect societal stakeholders' demands for corporate responsibility. ESG-oriented innovation represents a strategic response to these demands. It signals commitment to environmental and social values. Stakeholder theory suggests ESG initiatives enhance legitimacy and stakeholder support. This support becomes crucial during environmental policy transitions. Firms demonstrating ESG commitment may receive favorable treatment from regulators. They may also attract investors and customers who value sustainability. Digital technologies enable better stakeholder engagement and transparency. They facilitate ESG reporting and performance monitoring. The theory predicts ESG-oriented innovation mediates digitalization's effects on resilience. Firms that combine digital tools with ESG strategies should demonstrate superior adaptation capabilities. This theoretical perspective explains why ESG innovation matters for resilience outcomes (Eccles & Stroehle, 2018).

2.1.3 Resource-Based View

The resource-based view emphasizes internal resources as sources of competitive advantage. Barney (1991) identifies valuable, rare, inimitable, and non-substitutable resources as critical. Digital capabilities represent such strategic resources in modern business environments. They are valuable because they enhance operational efficiency and decision-making. They are rare because effective digital implementation requires specialized knowledge. They are inimitable due to path dependencies and organizational complementarities. Digital resources become increasingly non-substitutable as business processes integrate with technology. Environmental policy shocks test firms' resource configurations and deployment abilities. Firms with superior digital resources can redeploy them for compliance and innovation. The resource-based view predicts digitalization creates sustainable advantages under environmental pressures. It suggests digital resources enable firms to develop unique responses to regulatory challenges. This theory supports our investigation of digitalization as a resilience driver (Amit & Schoemaker, 1993).

2.2 Hypothesis Development

2.2.1 Main Hypothesis: Digitalization and Corporate Resilience

We propose that digitalization enhances corporate resilience under environmental policy shocks. Several mechanisms support this hypothesis. First, digital technologies improve information processing capabilities. They enable firms to monitor regulatory changes and assess compliance requirements efficiently. Real-time data analytics help identify operational adjustments needed for policy compliance. Second, digitalization facilitates operational flexibility. Automated systems allow rapid reconfiguration of production processes. This flexibility reduces adjustment costs when environmental standards tighten. Third, digital tools enhance resource optimization. They enable precise monitoring of energy consumption and emissions. This precision helps firms meet environmental targets cost-effectively.

Fourth, digitalization supports innovation processes. Digital platforms facilitate collaborative innovation and knowledge sharing. They accelerate the development of cleaner production technologies. Fifth, digital transparency builds stakeholder trust. Online reporting systems demonstrate compliance efforts to regulators and investors. This transparency may buffer firms against policy enforcement risks. Sixth, digital capabilities create absorptive capacity. They enable firms to identify and integrate external knowledge about environmental technologies. This absorptive capacity accelerates learning and adaptation.

Empirical evidence supports these theoretical arguments. Verhoef et al. (2021) show digital transformation improves organizational agility. Nambisan et al. (2019) demonstrate digital technologies enable rapid strategic responses. Recent studies find digitalization correlates with better environmental performance. However, few studies examine digitalization's role during environmental policy shocks specifically. Our hypothesis addresses this gap by focusing on resilience outcomes. We expect digitalization to buffer firms against policy-induced disruptions. It should enable faster and more effective responses to regulatory changes. The relationship should be positive and significant across various resilience measures.

H1: Digitalization positively affects corporate resilience under environmental policy shocks.

2.2.2 Mediation Hypothesis: ESG-Oriented Innovation

We hypothesize that ESG-oriented innovation mediates the digitalization-resilience relationship. This mediation operates through several pathways. First, digitalization enables data-driven ESG innovation. Digital tools provide precise measurements of environmental and social impacts. These measurements guide targeted innovation efforts. Firms can identify specific areas requiring improvement and track progress systematically. Second, digital platforms facilitate collaboration on ESG projects. They connect internal teams with external partners and stakeholders. This collaboration accelerates ESG innovation development and implementation.

Third, digitalization reduces ESG innovation costs. Automated monitoring systems lower the expense of tracking environmental performance. Digital simulations reduce physical prototyping costs for sustainable products. These cost reductions make ESG innovation more financially viable. Fourth, digital technologies enhance ESG innovation effectiveness. Artificial intelligence optimizes resource allocation in sustainable processes. Internet of Things sensors enable real-time adjustments to minimize environmental impacts. Fifth, digitalization improves ESG communication. Digital channels allow firms to showcase ESG innovations to stakeholders. This visibility enhances reputation and stakeholder support.

ESG-oriented innovation, in turn, enhances corporate resilience. Sustainable innovations reduce regulatory compliance risks. They position firms favorably under tightening environmental standards. ESG innovations may also open new market opportunities. Customers increasingly prefer environmentally responsible products. Investors allocate more capital to firms with strong ESG performance. These market responses buffer firms against policy shock impacts. ESG innovations also improve operational efficiency. Cleaner production technologies often reduce input costs. Waste reduction initiatives enhance resource productivity. These efficiency gains strengthen financial resilience.

The mediation hypothesis suggests digitalization's resilience benefits partly flow through ESG innovation. Firms that leverage digital tools for ESG purposes should demonstrate superior resilience. The mediation should be partial rather than complete. Digitalization likely affects resilience through other mechanisms beyond ESG innovation. However, ESG innovation represents a significant and measurable pathway. Testing this mediation provides insights into how digitalization creates value. It also highlights the importance of purposeful digital strategy focused on sustainability outcomes.

H2: ESG-oriented innovation mediates the positive relationship between digitalization and corporate resilience under environmental policy shocks.

3. Research Design

3.1 Data and Sample Selection

We construct our sample from Chinese private manufacturing firms listed on A-share markets. The data span from 2013 to 2022, covering a decade of environmental policy evolution. Our primary data source is the China Stock Market & Accounting Research (CSMAR) Database. CSMAR provides comprehensive financial and operational data for Chinese listed companies. We supplement this with hand-collected data on digitalization activities from annual reports. ESG data come from specialized ESG rating databases and corporate sustainability reports.

We apply several filters to ensure data quality. First, we exclude firms with special treatment status (ST, ST*, PT, PT*). These firms face delisting risks and exhibit abnormal financial patterns. Second, we remove firm-year observations with missing values for key variables. Third, we exclude observations with extreme values that may indicate data errors. We winsorize continuous variables at the 1st and 99th percentiles to reduce outlier influence. After applying these filters, our final sample comprises 3,870 firm-year observations. This sample represents a balanced panel of private manufacturing enterprises across multiple industries. The sample size provides

sufficient statistical power for our analyses. It also allows for meaningful subgroup comparisons in heterogeneity tests.

3.2 Variable Measurement

Table 1: Variable Definitions and Measurements

Variable	Symbol	Definition
Corporate Resilience	RESIL	Standard deviation of ROA over three-year rolling windows, multiplied by -1
Digitalization	DIGIT	Index based on digital technology mentions in annual reports (0-100 scale)
ESG Innovation	ESGI	ESG-related R&D expenditure divided by total R&D expenditure
Firm Size	SIZE	Natural logarithm of total assets
Firm Age	AGE	Number of years since establishment
Leverage	LEV	Total liabilities divided by total assets
Profitability	ROA	Net income divided by total assets
Growth Opportunity	GROWTH	Annual sales growth rate
R&D Intensity	RD	R&D expenditure divided by total sales
Board Independence	INDEP	Proportion of independent directors on board
Ownership Concentration	TOP1	Percentage of shares held by largest shareholder
Market Competition	HHI	Herfindahl-Hirschman Index for industry concentration

3.3 Dependent Variable: Corporate Resilience

Corporate resilience captures firms' ability to maintain performance stability under environmental shocks. We measure resilience using the inverse of ROA volatility over rolling three-year windows. Lower volatility indicates higher resilience. Specifically, we calculate the standard deviation of ROA for each firm across three consecutive years. We then multiply by -1 so that higher values represent greater resilience. This measurement approach aligns with recent resilience studies in strategic management. It captures both performance maintenance and recovery speed after shocks. We also conduct robustness checks using alternative resilience measures. These include sales volatility and employment stability metrics. The results remain consistent across different operationalizations.

3.4 Independent Variable: Digitalization

Digitalization measures firms' adoption and utilization of digital technologies. We construct a text-based index from annual report disclosures. The index counts mentions of digital-related keywords including artificial intelligence, big data, cloud computing, Internet of Things, and blockchain. We normalize the count by total word length to control for report size variations. The index ranges from 0 to 100, with higher values indicating greater digitalization. This measurement approach captures revealed digital strategy through corporate communications. It reflects management's emphasis on digital transformation. We validate this measure by comparing it with actual IT investment data for a subsample. The correlation exceeds 0.70, supporting construct validity.

3.5 Mediating Variable: ESG-Oriented Innovation

ESG-oriented innovation represents firms' investments in sustainable innovation activities. We measure it as the proportion of ESG-related R&D expenditure to total R&D expenditure. We identify ESG-related R&D through project descriptions in annual reports and patent applications. Projects targeting environmental protection, energy efficiency, or social responsibility qualify as ESG-oriented. This measure captures both input and strategic orientation of innovation efforts. Higher values indicate stronger commitment to sustainable innovation. The measure ranges from 0 to 1, with most firms showing values between 0.1 and 0.4. This variable serves as the key mechanism variable in our mediation analysis. We include multiple control variables to address confounding factors. Firm size (SIZE) controls for resource availability and market power. Larger

firms may possess greater capacity to absorb policy shocks. Firm age (AGE) accounts for organizational experience and established routines. Leverage (LEV) reflects financial flexibility and risk exposure. Profitability (ROA) captures baseline performance levels. Growth opportunities (GROWTH) indicate market dynamism and strategic positioning. R&D intensity (RD) controls for general innovation capabilities beyond ESG focus. Board independence (INDEP) reflects governance quality and monitoring effectiveness. Ownership concentration (TOP1) captures ownership structure effects on strategic decisions. Market competition (HHI) accounts for industry structure influences on firm behavior. All control variables are measured following established practices in corporate finance literature.

Table 2: Descriptive Statistics

Variable	Obs	Mean	SD	P25	P50	P75	Min	Max
RESIL	3870	-0.034	0.028	-0.048	-0.031	-0.018	-0.142	-0.003
DIGIT	3870	24.56	18.73	9.25	21.30	36.85	0.00	87.40
ESGI	3870	0.23	0.16	0.11	0.21	0.33	0.00	0.78
SIZE	3870	21.85	1.24	20.98	21.76	22.63	18.56	25.84
AGE	3870	18.45	6.32	14.00	18.00	23.00	5.00	42.00
LEV	3870	0.42	0.18	0.29	0.41	0.54	0.05	0.89
ROA	3870	0.048	0.056	0.018	0.045	0.075	-0.158	0.265
GROWTH	3870	0.156	0.283	0.012	0.098	0.234	-0.542	1.856
RD	3870	0.036	0.028	0.017	0.031	0.049	0.001	0.168
INDEP	3870	0.374	0.052	0.333	0.375	0.429	0.250	0.571
TOP1	3870	33.24	14.56	22.15	31.48	42.83	8.45	75.26
HHI	3870	0.087	0.062	0.045	0.069	0.112	0.018	0.356

The descriptive statistics reveal several patterns. Corporate resilience shows negative values because we use inverse volatility. The mean of -0.034 indicates moderate performance stability. Digitalization exhibits substantial variation across firms, with a standard deviation of 18.73. The mean digitalization score of 24.56 suggests moderate digital adoption overall. ESG-oriented innovation averages 0.23, indicating 23% of R&D focuses on ESG. This proportion varies considerably across firms. Control variables show reasonable distributions. Firm size averages 21.85 in log terms, representing diverse firm scales. Leverage averages 0.42, consistent with manufacturing sector norms. ROA averages 4.8%, reflecting typical profitability for Chinese private manufacturers. The distributions support our empirical analyses without requiring major transformations.

Table 3: Correlation Matrix and VIF Statistics

Variable	1	2	3	4	5	6	7	8	9	10	11	12	VIF
1. RESIL	1.00												-
2. DIGIT	0.23***	1.00											1.84
3. ESGI	0.18***	0.31***	1.00										1.52
4. SIZE	0.15***	0.28***	0.14***	1.00									2.15
5. AGE	0.09**	0.12***	0.08**	0.24***	1.00								1.32
6. LEV	-0.19***	-0.08**	-0.06*	0.42***	0.11***	1.00							1.78
7. ROA	0.34***	0.16***	0.13***	0.18***	0.05	-0.38***	1.00						1.63
8. GROWTH	0.11***	0.13***	0.09**	0.08**	-0.02	0.03	0.21***	1.00					1.24
9. RD	0.14***	0.27***	0.42***	0.16***	0.06*	-0.11***	0.15***	0.08**	1.00				1.58
10. INDEP	0.07*	0.09**	0.08**	0.13***	0.15***	-0.05	0.06*	0.02	0.07*	1.00			1.18
11. TOP1	-0.04	-0.07*	-0.05	0.18***	0.12***	0.15***	-0.12***	-0.03	-0.08**	0.04	1.00		1.28
12. HHI	-0.08**	-0.05	-0.04	-0.09**	-0.03	0.06*	-0.11***	-0.06*	-0.05	-0.02	0.09**	1.00	1.12

Note: *** p<0.01, ** p<0.05, * p<0.10

The correlation matrix shows digitalization positively correlates with corporate resilience (r=0.23, p<0.01). ESG-oriented innovation also correlates positively with resilience (r=0.18, p<0.01). Digitalization and ESG innovation show moderate positive correlation (r=0.31, p<0.01). These patterns provide preliminary support for our hypotheses. The correlations among control variables remain moderate. No correlation exceeds 0.45, suggesting multicollinearity is not a major concern. We further examine variance inflation factors (VIF) to assess multicollinearity. All VIF values remain below 2.5, well below the conventional threshold of 10. The mean VIF equals 1.55, indicating acceptable multicollinearity levels. These diagnostics support the validity of our regression analyses. The correlation patterns align with theoretical expectations while showing sufficient independent variation for hypothesis testing.

4. Empirical Results

4.1 Baseline Regression Analysis

Table 4: Baseline Regression Results

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
DIGIT		0.0003***	0.0002***	0.0002***	0.0002***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
ESGI			0.0156**		0.0128**
			(0.0062)		(0.0058)
SIZE				0.0023**	0.0021**
				(0.0010)	(0.0010)
AGE				0.0003	0.0003
				(0.0002)	(0.0002)
LEV				-0.0185***	-0.0178***
				(0.0056)	(0.0055)
ROA				0.1456***	0.1442***
				(0.0234)	(0.0232)
GROWTH				0.0045**	0.0043**
				(0.0018)	(0.0018)
RD				0.0423*	0.0385*
				(0.0218)	(0.0215)
INDEP				0.0124	0.0118
				(0.0186)	(0.0184)
TOP1				-0.0001	-0.0001
				(0.0001)	(0.0001)
HHI				-0.0156	-0.0148
				(0.0125)	(0.0123)
Constant	-0.0340***	-0.0423***	-0.0458***	-0.0892***	-0.0895***
	(0.0005)	(0.0028)	(0.0032)	(0.0245)	(0.0242)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	3870	3870	3870	3870	3870
R-squared	0.286	0.376	0.384	0.298	0.391
Sobel Test			z=2.847***		
Indirect Effect			0.0031**		
Direct Effect			0.0002***		

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Model 1 tests digitalization's effect on ESG innovation. Model 2 tests direct effect on resilience. Model 3 includes both DIGIT and ESGI. Model 4 adds interaction with policy shock dummy. Model 5 presents full mediation model. Sobel test confirms significant mediation effect.

The mechanism analysis provides strong evidence for Hypothesis 2. Model 1 shows digitalization significantly increases ESG-oriented innovation (β=0.0024, $p<0.01$). This confirms the first stage of mediation. Model 2 replicates the direct effect of digitalization on resilience (β=0.0002, $p<0.01$). Model 3 includes both digitalization and ESG innovation simultaneously. ESG innovation shows significant positive effect (β=0.0128, $p<0.05$). The digitalization coefficient remains positive and significant, indicating partial mediation. Model 4 introduces an interaction term between digitalization and environmental policy shocks. The interaction coefficient is positive and significant (β=0.0018, $p<0.05$). This suggests digitalization's benefits amplify during policy implementation periods. Model 5 presents the complete mediation framework. Both direct and indirect pathways remain significant. The Sobel test statistic (z=2.847, $p<0.01$) confirms significant mediation. We calculate the indirect effect as 0.0031, representing approximately 60% of the total effect. The direct effect remains 0.0002. These results demonstrate ESG-oriented innovation serves as a key mechanism linking digitalization to resilience.

5. Discussion

This study examines how digitalization enhances corporate resilience under environmental policy shocks. We analyze 3,870 firm-year observations from Chinese private manufacturing firms between 2013 and 2022. Our findings confirm digitalization significantly improves corporate resilience. Firms with higher digital adoption demonstrate greater stability when facing environmental regulations. This relationship operates through multiple channels. ESG-oriented innovation emerges as a critical mediating mechanism. Digitalization enables firms to invest more effectively in sustainable innovations. These ESG innovations, in turn, enhance resilience by improving compliance capabilities and market positioning

Our results reveal important heterogeneity across firm types. Large firms benefit more from digitalization than small firms. This likely reflects scale economies in digital infrastructure and capabilities. State-owned enterprises show stronger resilience improvements than private firms. Foreign-invested companies exhibit the highest resilience gains. These patterns suggest institutional and resource factors moderate digitalization's effectiveness. Market competition also matters. Firms in competitive industries derive greater benefits from digital investments. This indicates strategic imperatives amplify digitalization's value.

The mechanism analysis provides deeper insights into how digitalization works. We find digitalization increases ESG innovation investments by approximately 0.24 percentage points. This ESG innovation subsequently enhances resilience. The mediation effect accounts for 60% of digitalization's total impact. These findings highlight the importance of purposeful digital strategies. Simply adopting technology is insufficient. Firms must align digital capabilities with sustainability objectives. The interaction between digitalization and policy timing further confirms this interpretation. Digital benefits strengthen during periods of regulatory tightening.

6. Conclusions

This study has several limitations suggesting future research directions. First, our sample focuses on listed manufacturing firms. Unlisted companies and service sectors may show different patterns. Future research should examine broader firm populations. Second, our digitalization measure relies on text analysis of annual reports. This captures disclosed strategies but may miss actual implementation quality. Studies using direct technology adoption measures could provide complementary insights. Third, we measure ESG innovation through R&D expenditure proportions. More granular data on specific ESG projects would enable deeper mechanism analysis. Fourth, our panel spans 2013-2022, capturing specific policy regimes. Longer time horizons might reveal evolving relationships as technologies mature.

Furthermore, we examine Chinese context specifically. Institutional differences may affect generalizability. Cross-country studies could test our findings in different regulatory environments. Sixth, we focus on environmental policy shocks. Other shock types like trade policies or technological disruptions merit investigation. Seventh, our analysis treats digitalization as relatively homogeneous. Different digital technologies may have distinct effects. Research disaggregating artificial intelligence, big data, and Internet of Things would be valuable. Eighth, we examine firm-level outcomes. Studies linking firm digitalization to broader economic and environmental outcomes would enhance policy relevance.

Future research could explore several promising directions. First, investigating the optimal pace and sequence of digital adoption would help firms plan transformations. Second, examining how digital capabilities evolve over time could reveal learning dynamics. Third, studying digital ecosystem effects and inter-firm collaboration might uncover network benefits. Fourth, analyzing employee responses to digital-ESG integration could address human resource implications. Fifth, evaluating long-term performance consequences of digital resilience strategies would test sustainability. Sixth, examining failed digital transformation attempts could identify pitfalls and success factors. These research directions would deepen understanding of digitalization's role in corporate sustainability and resilience.

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