

DIGITALIZATION'S IMPACT ON FINANCIAL PERFORMANCE IN CHINESE LISTED FIRMS: ROLE OF COST REDUCTION, EFFICIENCY IMPROVEMENT, AND INNOVATION CAPABILITIES

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Abstract

China's economic growth is increasingly driven by the digital economy, requiring enterprises to enhance their competitiveness through digitalization. This shift is not only a trend but also a critical component of national innovation strategies. However, many businesses face challenges in digital operations due to a lack of understanding of the processes and benefits of digitalization. This study aims to address these challenges by exploring how different digitalization levels affect firms' financial performance, with a particular focus on cost reduction, efficiency improvements, and innovation capabilities. Data from 276 listed companies in China's A-share market from 2018 to 2022 were analyzed using a fixed effects model. By incorporating time lags into the analysis, the temporal stability of these relationships was assessed. The research findings indicate that digitalization positively impacts firm performance both in the short term and over slightly longer periods, but this effect diminishes over time, highlighting the need for continuous investment and strategic adaptation to sustain these benefits. The findings further show that cost reduction and efficiency improvement capabilities mediate the relationship between digitalization and firm performance, suggesting that operational efficiencies are the primary drivers of performance gains from digital initiatives. However, innovation capability does not significantly moderate this relationship, implying that while digitalization enhances performance through improved operations, innovation does not substantially alter this effect. Therefore, companies should prioritize leveraging digitalization to optimize operations and continuously adapt their digital strategies to maintain performance benefits over time.

Keywords: Cost Reduction, Digitalization, Efficiency Improvements, Fixed Effects, Innovation, Time Lag.

INTRODUCTION

The rise of the global digital economy, characterized by big data, cloud computing, and artificial intelligence, has deeply influenced social development and business operations, making information a key asset for competitive advantage (Wu et al., 2023; Zhu et al., 2024). As China, now the world's second-largest economy, enters a new phase, its digital economy, accounting for over 30% of GDP, plays a crucial role in addressing modern challenges and fostering growth (Zhu et al. 2024).

Since 2016, industrial policies have catalyzed the adoption of digital technology and intelligent manufacturing across firms, highlighting digitalization's critical role in boosting the national economy's growth and advancing enterprise-level management and operations (Wang et al., 2023; Yang & Han, 2023; Li et al., 2023). Consequently, industries across the board are actively pursuing digital transformation and integrating advanced digital technologies, aiming for successful changes and increased enterprise value. This digital overhaul has profoundly reshaped the development and production models of traditional manufacturing in China (Ren et al. 2023).

However, despite these efforts, only 7% of Chinese enterprises have realized the economic benefits of digitalization. Many still grapple with challenges such as awareness, conditions, capabilities, and methodologies, which not only hinder effective digital operations but can also escalate operational costs (Yu et al., 2021). This trend aligns with China's national innovation strategy and mirrors global trends in information technology (Zhu et al., 2024). Moreover, while numerous studies highlight the significant opportunities digitalization offers for enhancing firm performance, its impact varies significantly depending on the sector, geographic region, and specific digital capabilities employed. The inconsistent findings across studies underscore the need for further research to uncover the conditions under which digitalization most effectively enhances performance.

This study comprehensively analyzes the direct impact of digitalization on performance among 276 listed companies in China's A-share market from 2018 to 2022. It explores the mediating effects of cost reduction and efficiency improvement capabilities and examines how innovation capability moderates this relationship. Incorporating time-lag analysis, the study investigates the delayed effects of digital transformation investments on firm outcomes, offering a longitudinal perspective often overlooked. Using a fixed effects model on panel data ensures robustness, accounting for unobserved firm heterogeneity. This nuanced approach provides practical insights for Chinese enterprises navigating the dynamic digital economy, highlighting the temporal stability of digitalization's impacts.

LITERATURE REVIEW

Relationship between Digitalization and Firm Performance

Digitalization profoundly affects the strategic context, structure of competition, business conduct, and ultimately, performance across industries (Wang et al., 2023; Zheng et al. 2022; Matoušková, 2022; Liu et al., 2020). A plethora of existing research has explored the impact of digitalization on firm performance and the inconsistent conclusions depicts a notable gap in understanding the relationship between digitalization and firm performance.

Wang et al. (2023) conducted a study on digitalization's impact in the Shanghai and Shenzhen software and information technology service sectors; analyzing 1,663 A-share listed companies. Their research, using ordinary least squares (OLS) regression, demonstrated that escalating levels of digital capabilities—from basic integration to advanced business model integration—positively affect enterprise performance. This highlights digital technologies' transformative potential in enhancing operational efficiency and competitive advantage.

Meanwhile, Zhu et al. (2024) and Ren et al. (2023) focused on digitalization's effects on management performance in Chinese-listed firms. Zhu et al. (2024) utilized an imbalanced panel dataset covering 865 instances from 132 Chinese automobile manufacturing firms, employing a two-way fixed-effects model. They found that higher degrees of digitalization significantly correlated with improved financial performance, emphasizing digital strategies' role in boosting productivity and operational efficiency. Ren et al. (2023), using OLS regression on annual report data from 2009 to 2020, explored factors like company age and board

knowledge level related to digitalization's impact, highlighting its broad influence on organizational performance. Contrasting findings from studies like Zheng et al. (2022) and Cheng et al. (2022) suggest complexities in digital adoption. Zheng et al. (2022) observed a negative relationship between digitalization and performance in Chinese banks, while Cheng et al. (2022) found no significant profit impact in service industries despite enhanced asset utilization. These studies collectively underscore the sector-specific challenges and varied impacts of digitalization on firm performance, advocating for tailored strategies to maximize its benefits across industries.

Exploration of digitalization's impact on firm performance is also evident not only in China but also in other countries. Kádárová et al. (2023) investigated the link between digitalization and business performance in European SMEs during the COVID-19 pandemic, using a dataset of 135 observations spanning five years from 27 European countries. Their findings highlighted that higher digital intensity significantly improves business performance. Akhmadalieva and Akhmadalieva (2022) explored the impact of digitalization on firms' productivity in Central Asian countries, showing a substantial productivity increase due to digitalization. The authors recommend further exploration of digitalization's impacts across various industries and advocate for employing advanced analytical methods, such as fixed-random effects models, to gain deeper insights. In Indonesia, Wujarso (2023) found that digitalization enhances operational efficiency in the manufacturing sector. However, contrasting findings by Coryanata et al. (2023) revealed the negative impacts of bank digitization on financial performance in Indonesian banks, indicating varied effects of digitalization across sectors and regions. These studies underscore the global relevance of digitalization's impact on firm performance, emphasizing the need for context-specific strategies and further research to fully understand its implications. Given the varied findings across studies regarding the relationship between digitalization and performance, alongside the inherent context-dependence of digitalization, this study posits that the extent of digitization in enterprises significantly influences their performance. Building on this premise, the study hypothesized that:

H1: Digitalization affects firm performance.

Influencing Effects of Cost Reduction, Efficiency Improvement, and Innovation Capabilities

Cost reduction, efficiency improvement, and innovation capabilities play crucial roles in the digitalization process and subsequent firm performance. Research indicates that digitalization significantly enhances firm performance by reducing external management costs and strengthening internal controls, ultimately leading to improved performance (Gao et al., 2023; Alaskar, 2023; Shah et al. 2024). In the digital economy, corporate operations benefit from reduced coordination costs, enhanced information sharing, and streamlined communication (Qi & Cai, 2019; Zhao et al., 2024; Xie, 2024; Jain & Sahu, 2023; Sun & Wang, 2023). Gao et al. (2023) demonstrated that digitalization enhances firm performance by reducing external management costs and strengthening internal controls, particularly benefiting state-owned enterprises more than non-state-owned ones. This aligns with studies showing that digital technologies optimize economic costs such as search, replication, and tracking, enhancing

enterprise value through efficient labor utilization (Ma et al., 2024; Solona et al., 2023; Thrasson et al., 2020; Acemoglu & Restrepo, 2019; Goldfarb & Tucker, 2019). However, the impact of digitalization varies by context. Scafarto et al. (2023) explored the mediating role of smart capital efficiency in the effect of digitalization on EU healthcare firms' financial performance, finding a partial mediation effect of intellectual capital efficiency.

Digital technology revolutionizes organizational efficiency through automation, intelligence, and process enhancements (He & Qin, 2019; Andriole, 2019). It enables agile deployment of on-demand resources (Kane et al., 2015; Oktavian & Hasanah, 2023) and harnesses AI and big data to tailor products and services to customer needs (Loebbecke & Picot, 2015; Kuhl et al., 2020; Shanthana et al., 2023). Big data analytics accelerates decision-making (Cerbulescu et al., 2021; Sharma et al., 2023), empowering firms to optimize operations and gain competitive advantages (Qi & Cai, 2019). However, the impact of digitalization influenced by the cost reduction capability of the firm is not straightforward. Digital transformation refines business operations and decision systems, significantly enhancing operational efficiency and performance across sectors (Golzer & Fritzsche, 2017; Barabas et al., 2023; Nur & Komarudin, 2023). It allows companies to leverage user and production data for informed decision-making and cost management, thereby strengthening their ability to capture profits and maintain competitiveness in dynamic markets. It varies by enterprise type and sector, emphasizing the need for further analysis, thus this study hypothesized:

H2: Cost reduction capability mediates the relationship between the firm's digitalization level and performance.

In the digital economy, companies harness digital technologies for decision analysis and precision marketing, enhancing resource visibility and operational efficiency (An, 2021). These technologies also streamline supply chain connectivity, reduce information costs, and optimize resource allocation, thereby maximizing enterprise value (Wang, 2020; Chen, 2019). Scafarto et al. (2023) found that capital-employed efficiency acts as a mediator in the relationship between digitalization and firm performance within the EU healthcare sector. Park et al. (2021) highlighted how technological efficiency affects financial performance differently across high-tech and semiconductor firms. Hui et al. (2022) provided insights into regional and sectoral variations in digital efficiency among Chinese listed companies from 2018 to 2021. Their study revealed that while manufacturing sectors struggled with scaling digital inputs, non-manufacturing sectors, and non-state-owned enterprises optimized digital technologies more effectively. They emphasized the importance of tailored digital strategies based on regional, sectoral, and ownership contexts to maximize digitalization's benefits in different settings. Therefore, this study proposes the following hypothesis:

H3: Efficiency improvement capability mediates the relationship between digitalization level and firm performance

Digitalization enables firms to innovate and create value through advanced technologies, transforming business processes and accelerating product development (Kuester et al., 2018; Rachinger et al., 2019; Autio et al., 2021). This transformation enhances R&D capabilities,

identifies market opportunities, and supports agile responses to environmental changes, thereby boosting market share and revenue (Bresciani et al., 2021; Verhoef et al., 2021; Feng, 2022; Xun et al., 2022). Resource-based theory suggests digitalization provides firms with unique, difficult-to-replicate resources and capabilities, enhancing their competitive advantage (Huang et al., 2021; Li et al., 2021). Digital technologies also enhance data analysis and information processing, enabling timely product and service upgrades, continuous innovation, and long-term business performance and value maximization (Teece, 2018; Martínez-Caro et al., 2020; Li, 2021; Wang et al., 2023). Recent studies underscore innovation capability as a critical mediator in the digitalization-firm performance relationship. Alaskar (2023) showed how innovation capabilities mediate the impact of digitalization on Saudi Arabian firms' performance using PLS-SEM on 386 business analytics expert surveys. Similarly, Al-Sharif et al. (2023) found in a study of 313 service SME managers in the Klang Valley, Malaysia, that innovation capability, especially in client relations, marketing, and technology, mediates the link between entrepreneurial leadership and firm performance. Wang et al. (2023) examined 1,663 A-share listed companies in Shanghai and Shenzhen, revealing through OLS regression that innovation capability, particularly in business model innovation, enhances digital capabilities' positive impact on firm performance. These findings highlight innovation capability's crucial role in bridging digitalization and achieving competitive advantage and operational success. But the story does not end here. While innovation capability helps in understanding the pathway from digitalization to performance, it also plays a crucial role in determining the conditions under which digitalization is most effective. This study is guided by ongoing works that investigated the underlying mechanism and boundary condition of the effects of emerging digital technology on firms' innovation activities. This may help understand better, why despite numerous government efforts to promote the digitalization of enterprises meager number of Chinese enterprises have realized its economic benefits (Yu et al., 2021; Zhu et al. 2024).

Yang et al. (2023) provided empirical evidence demonstrating how digitalization can enhance firms' financial performance through the implementation of servitization as a mediating mechanism. Their study focused on 70 manufacturing companies in central China, revealing that the transformation context—specifically, organizational risk-taking tolerance and network capabilities—moderates the relationship between digitalization and firm performance. This indicates that the financial benefits derived from digitalization are significantly influenced by the firm's capacity to accept risk and its ability to establish and utilize network connections. Additionally, Zhou et al. (2023) examined the moderating role of technological capability in the relationship between the breadth of a firm's knowledge base and its innovation performance. Their moderated mediation analysis, conducted on data from A-share listed companies in the Shanghai and Shenzhen Stock Exchanges from 2011 to 2020, found that technological capability enhances the positive effects of a diverse knowledge base on innovation outcomes. This suggests that firms adept in adopting and integrating digital technologies are better positioned to leverage their knowledge assets for sustainable innovation and growth in the digital economy era. Both studies underscore the complex dynamics between digitalization, innovation capability, and firm performance. These insights collectively enhance

our understanding of how digital transformation and innovation capability interact to influence firm success. With this, the present investigation posits the subsequent hypothesis:

H4: Innovation capability moderate relationship between digitalization level and firm performance

METHODOLOGY

Data Sources

This study used a total of 276 Chinese listed firms' data from 2018 to 2022 (with a total of 1380 data points) to examine the relationship between various data variables and firm performance across different periods. The data was gathered from the China Stock Market and Accounting Research (CSMAR) Database. It underwent rigorous cleaning and processing to ensure quality and relevance. Steps included excluding firms that had not adopted digital technologies by 2018, addressing data gaps or anomalies, maintaining a consistent study period, excluding financial industry firms, and managing outliers. Also, the Winsorization technique was used to handle outliers in a dataset by limiting extreme values to a 1% level. This approach aimed to create a reliable dataset for analyzing the relationship between data variables and firm performance across different periods.

Variable Measurements

This study combines relevant theories and existing literature to define the variables in the model, which are defined as shown in Table 1.

Table 1: Variables Measurement

Variable Type	Variables	Variable Description
Independent Variable	Digitalization Level (DL)	The ratio of the annual amount of new digitization-related hardware and software investment by enterprises to business revenue
Dependent Variable	Financial Performance (Perf)	Return on Assets (ROA) Return on Equity (ROE)
Mediating Variables	Cost Reduction Capability (CRC)	Cost ratio
	Efficiency Improvement Capability (EIC)	Total asset turnover ratio
Moderating Variable	Innovation Capability (INC)	Number of patent applications
Control Variables	Firm size (Size)	Natural logarithm of year-end total assets
	Firm Age (Age)	Years of operation
	Debt-to-Asset Ratio (Lev)	Total liabilities at year-end/total assets at year-end
	Firm Growth (Growth)	Amount of operating income at the end of the year - amount of operating income at the beginning of the year)/amount of operating income at the beginning of the year
	Firm ownership attributes (OWN)	State-owned enterprises = 1; non-state-owned enterprises = 0
	Year	Dummy variable

Model Estimation

Following Scfarto et al. (2023), Coryanata et al. (2022), and Zhu et al. (2024), fixed-effects (FE) models analyze digitalization's impact on firms' financial performance, mediated by cost reduction and efficiency improvement capabilities, moderated by innovation capability, and investigated with time lag effects. In the dynamic Chinese market, where economic cycles and regulatory changes can influence outcomes, the FE model offers a robust framework. It controls for stable firm-specific traits like management style and company culture, focusing squarely on digitalization's long-term impact on financial performance. As such, the following models were constructed:

Model 1

$$Perf_{it} = \alpha_1 + \beta_1 DL_{it} + \sum_{k=1}^K \gamma_{1k} CV_{kit} + \delta_i + \lambda_t + \varepsilon_{it}$$

The model depicts the direct effect of digitalization on the financial performance of the firm, where, $Perf_{it}$ represents the financial performance, either ROA or ROE of the firm i at time t ; DL_{it} represents the digital level of the firm i at time t ; CV_{kit} represents the control variables for firm i at time t , indexed by k from 1 to K ; α_i stands for the overall intercept; β_1 and γ_{1k} are coefficients for DL on Perf and CV on Perf, respectively; δ_i is the unobserved firm-specific effect (fixed effect) that captures all time-invariant factors affecting financial performance, λ_t represents the time-fixed effects capturing any time-specific effects common across firms; and $\varepsilon_{i,t}$ denotes the residual term.

Model 2

$$Mediator_{it} = \alpha_2 + \beta_2 DL_{it} + \sum_{k=1}^K \gamma_{2k} CV_{kit} + \delta_i + \varepsilon_{it}$$

The model above depicts the effect of digitalization level on $Mediator_{it}$ which represents either the cost reduction capability (CRC) or efficient improvement capability (EIC) of the firm i at time t . β_2 is a coefficient for DL on the Mediator, γ_{2k} represents the coefficient CV on the Mediator while the other terms are defined previously.

Model 3

$$Perf_{it} = \alpha_3 + \beta_3 DL_{it} + \phi Mediator_{it} + \sum_{k=1}^K \gamma_{3k} CV_{kit} + \delta_i + \lambda_t + \varepsilon_{it}$$

This equation shows the combined effect of digitalization level and mediator (either CRC or EIC) on financial performance. The ϕ represents the coefficient Mediator on performance, indicating the indirect effect of DL on Perf through the mediators while β_3 is a coefficient for the direct effect of DL on Perf (Model 1) after accounting for mediators.

Model 4

$$Perf_{it} = \vartheta_0 + \vartheta_1 DL_{it} + \vartheta_2 INC_{it} + \vartheta_3 (DL_{it} \times INC_{it}) + \sum_{k=1}^K \gamma_k CV_{kit} + \delta_i + \lambda_t + \varepsilon_{it}$$

To test the moderating effect, the interaction term between DL and Innovation (DL * INC) was included as shown in Model 4. ϑ_1 , ϑ_2 and ϑ_3 are coefficients for digitalization, innovation capability, and their interaction terms.

Diagnostic tests such as the Hausman specification test and Variance Inflation Factor (VIF) were used to assess whether the unique errors are correlated with the regressors and to detect multicollinearity respectively. Furthermore, the study incorporated time lags into the analysis as a robustness test to enhance the credibility of the findings by ensuring the temporal stability of relationships expecting the possible delayed impacts of digitalization ($DL_{i(t-n)}$) on firm performance and providing deeper insights into the dynamic effects of the independent variables. All the models and tests were done using Stata 17.0 software.

RESULTS AND DISCUSSIONS

This study investigates how digitalization impacts the performance of 276 listed companies in China's A-share market. It examines the mediating effects of cost reduction and efficiency improvement capabilities, along with the moderating influence of innovation capability on this relationship. Before testing these hypotheses, VIF scores confirmed no multicollinearity issues, with all variables below a VIF score of 2 (see Table 2).

Table 2: Multicollinearity Test

Variables	Mean	SD	VIF	Tolerance
Financial Performance				
ROA	0.042	0.068	1.60	0.625
ROE	0.703	0.109	1.78	0.721
Digitalization Level (DL)	0.072	0.059	1.39	0.718
Cost Reduction Capability (CRC)	0.118	0.224	1.44	0.692
Efficiency Improvement Capability (EIC)	0.575	0.328	1.34	0.745
Innovation Capacity (IC)	4.848	16.582	1.01	0.992
Firm Size (Size)	22.380	1.441	1.81	0.553
Firm Age (Age)	8.719	7.123	1.34	0.746
Debt-to-Asset Ratio (Lev)	0.404	0.216	1.85	0.541
Firm Growth (Growth)	0.142	0.282	1.27	0.788
Firm ownership attributes (OWN)	1.697	0.460	1.72	0.889

Impact of Digitization Level on Financial Performance

Given the varied findings across studies regarding the relationship between digitalization and performance, and acknowledging the context-dependent nature of digitalization, this study primarily aimed to identify how the extent of digitalization in firms affects their performance. Table 3 shows FE regression results from Model 1a (DL – ROA) and Model 1b (DL – ROE).

Table 3: Fixed Effects Regression Results on the Impact of Digitalization Level on Firm Performance

Variables	Model 1a	Model 1b
	ROA	ROE
DL	0.539*** (11.60)	0.834*** (11.61)
Size	0.018* (2.11)	0.048*** (3.50)
Age	0.000 (0.05)	-0.003 (-0.33)
Lev	-0.222*** (-6.39)	-0.322*** (-5.29)
Growth	0.039*** (5.98)	0.064*** (6.14)
OWN	0.012 (-1.47)	0.025 (0.49)
_cons	-0.322 (-1.60)	-0.946*** (-2.91)
Firm fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
R ²	0.415	0.389
F	41.055	36.291

Note: ***, **, and * denote statistical significance at the .01%, 1%, and 5% levels of significance, respectively. The t-statistics (in parentheses) are based on standard errors adjusted for clustering at the firm level.

The fixed effects regression in Table 3 shows that digitalization significantly enhances a firm's ROA and ROE at the 0.01% level, controlling for Size, Leverage, Growth, Age, and Ownership. Firm size positively influences ROA ($p < .05$) and ROE ($p < .000$), while leverage negatively impacts both ($p < .000$). Growth significantly enhances ROA and ROE ($p < .000$). Firm age and ownership structure do not significantly affect performance. These results underscore digitalization's critical role in firm performance, supporting H1.

Table 4: Hausman Test Results on the Impact of Digitalization Level on Firm Performance

Variable	χ^2	df	p-value
ROA	30.28	6	.000
ROE	50.93	6	.000

Table 4 confirms the results of Table 3, showing that digitalization significantly ROA and ROE. The use of fixed effects models highlights the importance of firm-specific characteristics in assessing digital transformation's impact. This validation reinforces the positive relationship between digitalization and firm profitability. The findings are incongruent with various studies (Zhu et al. 2024; Wang et al., 2023; Kadarova et al., 2023; Wujarso, 2023; Akhmadalieva & Akhmadalieva, 2022) and contradict others (Coryanata, 2022; Cheng et al. 2022; Zheng et al. 2022). It suggests that investments in digital technologies can lead to immediate financial

improvements. This is particular for larger and growing firms, while also emphasizing the need for effective leverage management to fully realize the benefits of digitalization.

Mediating Effects of Cost Reduction and Efficiency Improvement Capacities on Digitization Level and Financial Performance Relationship

Building on recent studies, this work explores the role of digitalization in enhancing firm performance by reducing external management costs and strengthening internal controls. The tables illustrate the mediating effects of cost reduction and efficiency improvement capacities in the digitalization-performance relationship.

Table 5: Mediating Effect of Cost Reduction Capacity on the Digitalization Level and Financial Performance Relationship

Variables	Model 2a	Model 3a	Model 3b
	CRC	ROA	ROE
DL	1.309*** (8.19)	0.241*** (7.12)	0.398*** (6.76)
CRC		0.2271*** (13.62)	0.3332*** (11.21)
Size	0.069* (2.35)	0.002 (0.51)	0.025** (2.89)
Age	0.006 (0.17)	-0.001 (-0.45)	-0.005 (-1.47)
Lev	-0.496*** (-4.70)	-0.109*** (-4.93)	-0.156*** (-3.61)
Growth	0.096** (3.24)	0.018*** (4.95)	0.032*** (5.01)
OWN	0.017 (0.19)	0.008 (0.58)	0.019 (0.69)
_cons	-1.368 (-1.89)	-0.012 (-0.14)	-0.491** (-2.65)
Firm fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
R ²	0.250	0.815	0.715
F	15.549	86.888	50.086

Note: ***, **, and * denote statistical significance at the .01%, 1%, and 5% levels of significance, respectively. The t-statistics (in parentheses) are based on standard errors adjusted for clustering at the firm level.

Table 5 examines the mediating role of CRC in the relationship between DL and firm performance. Model 2a shows that DL significantly enhances CRC ($p < .000$). Models 3a and 3b indicate that CRC significantly affects both ROA and ROE ($p < .000$), suggesting firms that reduce costs effectively achieve better financial outcomes. Control variables show firm size positively influences performance in some models, leverage negatively impacts both ROA and ROE, and growth consistently enhances performance. These findings support H2, implying that investment in digital technologies to automate and optimize processes leads to improved financial performance. The finding confirms the claim of Mo and Yao (2024) that the impact of digitization on performance is usually considered to work through multiple pathways, where one of which is the CRC. Peng & Sun (2024) and Zhao et al. (2024) argued that heightened

digitization typically results in cost reduction. Digital technologies enable firms to automate and optimize business processes, thereby lowering expenditures on human resources and time (Chen et al., 2020), production costs (Lu et al., 2023), inventory and logistics costs (Tao et al., 2023), marketing expenses (Kuhl et al., 2020), and others that can eventually lead to improved performance and competitive advantage (Ren & Guo, 2021; Xu et al., 2022; Shah et al. 2024). It implies the crucial role of CRC as a mechanism through which digitalization impacts firm performance positively. The findings along with previous studies underscore the dual benefits of digitalization and cost management strategies in enhancing firm performance, providing valuable insights for strategic decision-making aimed at improving operational efficiencies and financial outcomes.

Table 6: Mediating Effect of Efficiency Improvement Capacity on the Digitalization Level and Firm Performance Relationship

Variables	Model 2b	Model 3c	Model 3d
	EIC	ROA	ROE
DL	0.520*** (5.90)	0.496*** (10.56)	0.760*** (10.52)
EIC		0.081*** (4.84)	0.142*** (4.44)
Size	-0.080*** (-4.50)	0.024** (2.98)	0.059*** (4.40)
Age	0.035** (3.20)	-0.003 (-0.37)	-0.008 (-0.88)
Lev	0.148* (2.11)	-0.234*** (-6.60)	-0.343*** (-5.43)
Growth	0.192*** (10.54)	0.024*** (3.45)	0.037*** (3.35)
OWN	-0.095* (-2.33)	0.019 (0.69)	0.039 (0.80)
_cons	2.159*** (5.36)	-0.498* (-2.58)	-1.253*** (-3.96)
Firm fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
R ²	0.361	0.433	0.410
F	19.210	37.791	33.001

Note: ***, **, and * denote statistical significance at the .01%, 1%, and 5% levels of significance, respectively. The t-statistics (in parentheses) are based on standard errors adjusted for clustering at the firm level.

Table 6 examines the mediating effect of EIC on the impact of DL on ROA and ROE. Model 2b shows that DL significantly enhances EIC ($p < .000$), which in turn improves both ROA and ROE ($p < .000$). Control variables have varied effects: size negatively impacts ROA but positively affects ROE, leverage negatively impacts both, and growth consistently enhances performance, while ownership structure shows no significant impact. These results highlight the critical role of EIC in boosting firm performance through digitalization, confirming H2. This finding confirms studies that argue EIC is pivotal in shaping the relationship between DL and performance. Enhanced digitization typically results in the optimization and automation of internal business processes, thereby boosting overall operational efficiency (Park et al., 2021;

Wang & Zhou, 2022). Digital technologies enable firms to streamline production lines and implement digital supply chain management systems for real-time monitoring and cost reductions in inventory and logistics (Xue et al., 2022b; Chen, 2023; Xiong et al., 2023). In short, this improved efficiency directly contributes to better corporate performance outcomes (Peng & Tao, 2022). Overall, both CRC and EIC underscore the multifaceted benefits of digitalization for firms. They illustrate that digitalization strategies can enhance firm competitiveness and profitability through various operational enhancements. Integrating findings from both tables can provide a comprehensive understanding of how firms can strategically leverage digital technologies to achieve sustainable growth and performance improvements.

Moderating Effect of Innovation Capacity on Digitization Level and Financial Performance Relationship

This study asserts that innovation capability both explains the pathway from digitalization to performance and determines effective digitalization conditions. Table 7 investigates the moderating role of innovation capacity on the relationship between DL and firm financial performance.

Table 7: Moderating Effect of Innovation Capacity on the Digitalization Level and Firm Performance Relationship

Variables	Model 4a	Model 4b
	ROA	ROE
DL	0.235*** (2.62)	0.835*** (10.92)
INC	0.003 (1.02)	-0.000 (-0.07)
DL*INC	0.002 (0.52)	0.001 (0.51)
Size	0.012* (2.36)	0.049*** (3.58)
Age	-0.161** (-4.03)	-0.008** (-2.94)
Lev	-0.205** (-9.24)	-0.326*** (-5.31)
Growth	0.057*** (4.15)	0.061*** (6.08)
OWN	-0.517 (-1.34)	0.024 (0.47)
_cons	-0.724*** (-8.45)	-0.934** (-2.93)
Firm fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
R ²	0.411	0.384
F	67.571	53.012

Note: ***, **, and * denote statistical significance at the .01%, 1%, and 5% levels of significance, respectively. The t-statistics (in parentheses) are based on standard errors adjusted for clustering at the firm level.

Models 4a and 4b show that the interaction term DL*INC is non-significant for both ROA and ROE, indicating that innovation capacity does not significantly moderate the relationship between digitalization level and financial performance. Control variables such as firm size and growth positively influence ROA and ROE, while age and leverage have negative impacts. Ownership structure has minimal effects. These findings highlight the critical role of digitalization in enhancing financial performance but suggest that innovation capacity does not significantly alter this relationship, leading to the rejection of H4.

This study challenges the predominant view that innovation capability uniformly shapes how firm digitalization impacts performance (Alaskar, 2023; Al-Sharif et al., 2023; Wang et al., 2023; Yang et al., 2023; Liu & Chen, 2024). The findings indicate that while innovation capability can influence the relationship between digitization and corporate performance, its moderating effect is not consistently significant. This inconsistency can be attributed to several factors. Firstly, innovation capability may not uniformly moderate this relationship across different contexts (Mendoza-Silva 2020; Zhao et al. 2024), with some firms experiencing a direct impact of digitization on performance rather than a moderated one (Bai et al., 2022; Li et al., 2020). Secondly, the multifaceted nature of innovation capability, including organizational culture, leadership, and resource allocation, leads to varied effects across firms and industries (Le & Lei, 2019; Iranmanesh et al., 2020; Lam et al., 2021; Feng et al., 2022), complicating its moderating influence. Thirdly, external factors such as market competition, industry size, and regulatory environments also influence this relationship, potentially overshadowing the moderating role of innovation capability (Xue et al., 2022; Gu & Zhu, 2022).

These findings, alongside other results from this study, suggest a nuanced perspective: while digitalization offers immediate benefits through cost savings and efficiency gains, innovation capability plays a critical role in sustaining and maximizing these benefits over the long term. Firms with strong innovation capabilities are better positioned to innovate continuously, adapt to technological advancements, and leverage digital opportunities for competitive advantage in the marketplace.

In conclusion, while innovation capability can influence the link between digitization and corporate performance, its moderating effect may not always be straightforward. Future research and practical applications should consider these diverse factors to comprehensively understand how digital transformation impacts corporate performance.

Robustness Tests

To ensure the robustness of the findings and the temporal consistency of relationships among variables, this study integrated time lags into the analysis. This approach anticipates the delayed impacts of digitalization on firm performance, offering deeper insights into the dynamic effects of the independent variables. Table 7 examines the time lag effect of DL on firm performance, focusing on ROA and ROE over two periods (t-1 and t-2).

Table 7: Time Lag Effect of Digitalization Level on Firm Performance

Variables	ROA		ROE	
	t-1	t-2	t-1	t-2
DL	0.090 (1.06)	-0.207*** (-3.47)	0.146 (0.99)	-0.301*** (-3.36)
Size	0.036* (2.25)	0.070* (2.48)	0.077** (2.85)	0.154** (3.05)
Age	0.000*** (0.01)	0.000 (0.01)	-0.006 (-0.44)	-0.007 (-0.47)
Lev	-0.223** (-3.84)	-0.217** (-3.27)	-0.357*** (-3.50)	-0.363** (-2.92)
Growth	0.071*** (5.09)	0.053*** (4.03)	0.115*** (5.39)	0.094*** (4.68)
OWN	0.045 (0.58)	0.195*** (18.51)	0.059 (0.47)	0.281*** (12.58)
_cons	-0.746* (-2.11)	-1.742*** (-2.92)	-1.580** (-2.67)	-3.614*** (-3.43)
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
R ²	0.242	0.346	0.241	0.337
F	12.052	-	10.409	-

Note: ***, **, and * denote statistical significance at the .01%, 1%, and 5% levels of significance, respectively. The t-statistics (in parentheses) are based on standard errors adjusted for clustering at the firm level.

The time lag analysis reveals that DL has a non-significant impact on ROA and ROE at t-1 but a significant negative impact at t-2 for both financial performance metrics ($p < .001$). This contrasts with the findings in Table 3, where DL has a significant positive immediate impact on both ROA and ROE. Furthermore, Table 7 highlights that larger firms gain more from digitalization, emphasizing the importance of leveraging size ($p < .05$) and prioritizing growth ($p < .01$) for sustained success. Higher leverage consistently harms financial performance across all models and periods ($p < .01$), underscoring the negative impact of elevated debt levels, while the effects of Age and Ownership vary. These findings suggest that while digitalization initially boosts performance, its benefits may wane or even reverse over time, potentially due to challenges in maintaining digital initiatives or delayed costs associated with digital transformation. This highlights opportunities for future studies to explore the long-term impacts of digitalization and identify strategies to sustain its benefits over time.

CONCLUSIONS AND RECOMMENDATIONS

This study analyzed how digitalization influences the financial performance of Chinese-listed firms, focusing on cost reduction, efficiency improvement, and innovation capabilities. It utilized data from 276 firms over 2018-2022 and developed an empirical framework to fill gaps in existing research. Based on the findings, the study revealed significant insights into the relationship between digitalization and firm performance. Initially, the findings consistently demonstrated digitalization's positive impact on ROA and ROE, highlighting its immediate

benefits in enhancing financial metrics. Moreover, the mediating roles of cost reduction and efficiency improvement capacities, showcase how these factors enhance the relationship between digitalization and financial performance. This underscores the critical role of streamlined processes and operational efficiency in translating digital investments into tangible financial gains over time. Furthermore, the study underscores the moderating effect of innovation capacity, suggesting that while digitalization fosters innovation opportunities, its impact varies across firms with differing innovation capabilities. This variability highlights the importance of nurturing robust innovation frameworks to maximize the long-term benefits of digital initiatives, as echoed by time lag effects. Here, the study reveals that while digitalization initially boosts performance, the sustainability of these gains diminishes over time without continuous adaptation and strategic innovation.

Implications

The study offers significant practical and theoretical implications. Practically, it highlights the importance of strategic digital investments to enhance efficiency and reduce costs. Organizations should prioritize technologies that automate processes and optimize operations for immediate financial benefits. Fostering a culture of innovation is crucial, supported by the moderating effect of innovation capacity, emphasizing continuous investment in R&D.

Theoretically, the study challenges simplistic views by revealing the nuanced role of innovation capability in moderating digitalization's effects. It shows the relationship is multifaceted and context-dependent, influenced by organizational dynamics and market conditions. Including time lags enriches theoretical frameworks by highlighting the temporal dynamics of digital transformation's impact on performance.

Overall, successful digitalization requires integrating advanced technologies, nurturing innovation capabilities, and adapting to changing market demands and technological advancements. This dual focus on practical implementation and theoretical refinement enhances both managerial decision-making and scholarly understanding in the field of digital transformation and firm performance.

Limitations and Future Research Agenda

While this study provides valuable insights, it has limitations. It may not cover all relevant factors, and variations in sampling, data collection, and analysis techniques could affect findings. The focus on Chinese listed companies limits the generalizability due to unique market and policy environments. Future research should use broader datasets and comparative studies across regions to enhance understanding of digital transformation's impact on corporate performance. Additionally, extending lag analysis beyond short-term periods (t-1 and t-2) is recommended to capture delayed benefits more comprehensively. Employing dynamic panel data models like the Generalized Method of Moments (GMM) could better understand temporal dynamics and mitigate potential endogeneity issues. This approach will deepen insights into digitalization's long-term effects on performance, offering practical implications for firms navigating digital transitions.

References

- 1) Acemoglu, D. & Restrepo, P. (2019). Automation and new tasks: How technology displaces and reinstates labor. *Journal of Economic Perspectives*, 33 (2): pp. 3–30. DOI 10.3386/w25684
- 2) Akhmadalieva, Z. & Akhmadalieva, Z. (2022). Impact of digitalization on firms' productivity. In *The 6th International Conference on Future Networks & Distributed Systems ICFNDS '22*, December 15, 2022, Tashkent, TAS, Uzbekistan. ACM, New York, NY, USA, 8 Pages. <https://doi.org/10.1145/3584202.3584254>
- 3) Alaskar, T.H. (2023). Innovation Capabilities as a mediator between business analytics and firm performance. *Sustainability*, 15, 5522. <https://doi.org/10.3390/su15065522>
- 4) Al-Sharif, A. M., Ali, M. H., Jaharuddin, N. S., Abdulsamad, A., & Jandab, A. (2023). The role of innovation capability in the relationship between entrepreneurial leadership and innovation performance in the SMEs service industry. *Advances in Social Sciences Research Journal*, 10(1), 264–278. <https://doi.org/10.14738/assrj.101.13802>
- 5) An, H. (2021). From the 14th Five-Year Plan, the construction direction of the new smart city is suggested. *Information and Communication Technology*, (01), 21-24+31.
- 6) Andriole, S. J. (2019). Five myths about digital transformation. *MIT Sloan Management Review*, 60(2): 30-32. DOI:10.7551/mitpress/11633.003.0005
- 7) Autio, E., Mudambi, R., & Yoo, Y. (2021). Digitalization and globalization in a turbulent world: Centrifugal and centripetal forces. *Global Strategy Journal*, 11, 3-16. <https://doi.org/10.1002/GSJ.1396>
- 8) Bai, F. P., Liu, D. H., & Dong, K. Y. (2022). How digital transformation affects enterprise financial performance-Analysis of multiple intermediary effects based on structural equations. *East China Economic Management*, (9) ,75-87.
- 9) Barabas, D., Panasiuk, O., & Kryvonos, A. (2023). Formation of the company's digital competitive advantages. *Mechanism of an Economic Regulation*, 2 (100), 12-18. <https://doi.org/10.32782/mer.2023.100.02>
- 10) Bresciani, S., Huarng, K., Malhotra, A., & Ferraris, A. (2021). Digital transformation as a springboard for product, process and business model innovation. *Journal of Business Research*, 128, 204-210. <https://doi.org/10.1016/J.JBUSRES.2021.02.003>
- 11) Cerbulescu, C.C., Marian, M., & Ganea, E. (2021). IoT big data management for improved response time. *22nd International Carpathian Control Conference (ICCC), Velké Karlovice, Czech Republic, 2021*, pp. 1-6, doi: 10.1109/ICCC51557.2021.9454644.
- 12) Chen, X., Zhang, X., & Xue, Y. (2020). The impact of digital transformation on firm performance: Evidence from China. *Sustainability*, 12(12), 4985. doi:10.3390/su12124985
- 13) Cheng, R., Ho, C. & Huang, S. (2023) Digitalization and firm performance: channels and heterogeneities, *Applied Economics Letters*, 30(17), pages 2401- 2406, <https://doi.org/10.1080/13504851.2022.2097178>
- 14) Coryanata, I., Ramli, E., Puspita, L. & Halimatusyadiah, H. (2023). Digitalization of banking and financial performance of banking companies. *International Journal of Social Service and Research*, 3(2), pages 366-371. <https://doi.org/10.46799/ijssr.v3i2.254>
- 15) Feng, X. B., Lei, M. Y., & Chen, L. Z. (2022). Review and Prospect of Digital Transformation Research of Manufacturing Enterprises. *The Science and Management*, 1-13. URL: <http://kns.cnki.net/kcms/detail/37.1020.G3.20220403.2126.009.html>
- 16) Gao, D., Yan, Z., Zhou, X., & Mo, X. (2023). Smarter and prosperous: Digital transformation and enterprise performance. *Systems* 11(329). <https://doi.org/10.3390/systems11070329>

- 17) Goldfarb, A. & Tucker, C. (2019). Digital economics. *Journal of Economic Literature*, 57(1): 3–43. DOI: 10.1257/jel.20171452
- 18) He, F., & Qin, Y. (2019). Research on the economic consequences of the digital transformation of real enterprises driven by innovation. *Journal of Dongbei University of Finance and Economics*, (05), pp. 45-52. <https://doi.org/10.19653/j.cnki.dbcjdxzb.2019.05.006>.
- 19) Golzer, F., & Fritzsche, A. (2017). Data-driven operations management: Organisational implications of the digital transformation in industrial practice. *Production Planning and Control*, 28(16), 1332-1343. DOI: 10.1080/09537287.2017.1375148
- 20) Golzer, F., & Fritzsche, A. (2017). Data-driven operations management: Organisational implications of the digital transformation in industrial practice. *Production Planning and Control*, 28(16), 1332-1343. DOI: 10.1080/09537287.2017.1375148
- 21) Gu, L. M., Li, H. H., & Zhang, Y. (2022). Research on the challenges and optimization path of urban digital transformation—Take the Shanghai Municipality, for example. *Journal of Xi'an Jiaotong University (Social Science edition)*, 42(03), 41-50. <https://doi.org/10.15896/j.xjtuskxb.202203005>
- 22) He, F., & Qin, Y. (2019). Research on the economic consequences of the digital transformation of real enterprises driven by innovation. *Journal of Dongbei University of Finance and Economics*, (05), pp. 45-52. <https://doi.org/10.19653/j.cnki.dbcjdxzb.2019.05.006>.
- 23) Huang, L. H., Zhu, H. L., Liu, W. H., Dou, Y. F., Wang, J. Z. Cai, L., & Chen, W. B. (2021). Enterprise digital transformation and management: A research framework and outlook. *Journal of Management Science*, (08), 26-35. <https://doi.org/10.19920/j.cnki.jmsc.2021.08.004>.
- 24) Iranmanesh, M., Kumar, K., Foughi, B., Mavi, R., & Min, N. (2020). The impacts of organizational structure on operational performance through innovation capability: innovative culture as moderator. *Review of Managerial Science*, 15, 1885 - 1911. <https://doi.org/10.1007/s11846-020-00407-y>.
- 25) Jain, S. & Sahu, R. (2023). A study of digital innovations in business and economy. *BSSS Journal of Management*, 14(1), pp. 85- 95. doi: 10.51767/jm1408
- 26) Kádárová J, Lachvajderová L, & Sukopová D. (2023). Impact of digitalization on SME performance of the EU27: Panel data analysis. *Sustainability*, 15(13). <https://doi.org/10.3390/su15139973>
- 27) Kane, G. C., Palmer, P. D., & Phillips, A. (2015). Strategy, not technology, drives digital transformation. *MIT Sloan Management Review and Deloitte University Press*, (14) 1-25. https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/strategy/dup_strategy-not-technology-drives-digital-transformation.pdf
- 28) Ku, E.C.S. (2024). Digital marketing innovation and industrial marketing: evidence from restaurants' service robots. *Asia Pacific Journal of Marketing and Logistics*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/APJML-02-2024-0185>
- 29) Kuester, S., Konya, E., & Schuhmacher, M. C. (2018). Get the show on the road: Go-to-market strategies for e-innovations of strat-ups. *Journal of Business Research*, (83), pp. 63-81. <https://doi.org/10.1016/j.jbusres.2017.09.037>
- 30) Kühl, N., Mühlthaler, M. & Goutier, M. (2020). Supporting customer-oriented marketing with artificial intelligence: automatically quantifying customer needs from social media. *Electron Markets* 30, 351–367. <https://doi.org/10.1007/s12525-019-00351-0>
- 31) Lam, L., Nguyen, P., Le, N., & Tran, K. (2021). The relation among organizational culture, knowledge management, and innovation capability: Its implication for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*. <https://doi.org/10.3390/JOITMC7010066>

- 32) Le, P., & Lei, H. (2019). Determinants of innovation capability: The roles of transformational leadership, knowledge sharing and perceived organizational support. *Journal on Knowledge Management*, 23, 527-547. <https://doi.org/10.1108/JKM-09-2018-0568>.
- 33) Liu, Y. Z., & Chen, L.M. (2024). Digital transformation, analyst focus, and enterprise innovation performance. *Journal of Yantai University (Philosophy and Social Sciences Edition)*, (01), 1-18. <https://doi.org/10.13951/j.cnki.issn1002-3194.2023.1104.07>.
- 34) Li, S., Gaoa, L., Hanb, C., Guptac, B, Alhalabid, W., & Almakdie, S. (2023). Exploring the effect of digital transformation on Firms' innovation performance. *Journal of Innovation & Knowledge*, 8. <http://dx.doi.org/10.1016/j.jik.2023.100317>
- 35) Li, X. S., Dang, L., & Zhao, C. Y. (2022). Digital transformation, integration into global innovation networks, and innovation performance. *China's Industrial Economy*, (10), 43-61. <https://doi.org/10.19581/j.cnki.ciejournal.2022.10.003>.
- 36) Li, X., Wu, F. X., & Zhu, L.L. (2021). Digital economy and regional innovation performance. *Journal of Shanxi University of Finance and Economics*, (05), 17-30. <https://doi.org/10.13781/j.cnki.1007-9556.2021.05.002>.
- 37) Liu, Z., & Zhang, C.Z.R. (2020). Research on the design of home elderly entertainment services based on user perceived value theory. *Industrial & Engineering Design*, 05, pp. 65-73. <https://doi.org/10.19798/j.cnki.2096-6946.2020.05.010>
- 38) Loebbecke, C., & Picot, A. (2015). Reflections on societal and business model transformation arising from digitization and big data analytics: A research agenda. *The Journal of Strategic Information Systems*, 24(3), 149-157. <https://doi.org/10.1016/j.jsis.2015.08.002>
- 39) Lu, H.Y., Zhang, S.B., Zhao, S.Y., Zhang, M., & Zhang, P.G. (2023). Research on the relationship between promotion models and consumers' purchase intentions in live-streaming e-commerce taking perceived value as a mediator. *Trade Fair Economy*, (19), 54-58. <https://doi.org/10.19995/j.cnki.CN10-1617/F7.2023.19.054>
- 40) Ma, H., Chen, S., Liu, X. & Wang, P. (2024). Enterprise digital development and capacity utilization. *China Accounting and Finance Review*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/CAFR-04-2023-0046>
- 41) Martínez-Caro, E., Cegarra-Navarro, J., & Alfonso-Ruiz, F. (2020). Digital technologies and firm performance: The role of digital organisational culture. *Technological Forecasting and Social Change*, 154, 119962. <https://doi.org/10.1016/j.techfore.2020.119962>.
- 42) Matoušková, D. (2022). Digitalization and its impact on business. *Theory, Methodology, Practice - Review of Business and Management*, 18(02), 51–67. <https://doi.org/10.18096/TMP.2022.02.03>
- 43) Mendoza-Silva, A. (2020). Innovation capability: A systematic literature review. *European Journal of Innovation Management*. 24 (3), pp. 707-734. <https://doi.org/10.1108/ejim-09-2019-0263>.
- 44) Mo, S., & Yao, X.D. (2024). Digitalization, enterprise heterogeneity, and export performance. *International Business (Journal of the University of International Business and Economics)*, (01), 21-40. <https://doi.org/10.13509/j.cnki.ib.2024.01.002>.
- 45) Nur, R., & Komarudin, K. (2023). Digital transformation in business operations management. *American Journal of Economic and Management Business*, 2(9) doi: 10.58631/ajemb.v2i9.57
- 46) Oktavian, R., & Hasanah, U. (2023). The role of the digital economy in increasing employee performance. *Almana: Jurnal Manajemen dan Bisnis*, 7(1), p.193-200 doi: 10.36555/almana.v7i1.2155
- 47) Park, J., Chung, H., Kim, K., Kim, J., & Lee, C. (2021). The impact of technological capability on financial performance in the semiconductor industry. *Sustainability*, 13(2). <https://doi.org/10.3390/SU13020489>.

- 48) Peng, X. X., & Sun, W. (2024). Study on the influence of digital transformation and debt financing cost on enterprise performance. *China-Arab States Science and Technology Forum (Chinese and English)*, (01), pp. 64-68.
- 49) Peng, Y. Z., & Tao, C. Q. (2022). Can digital transformation promote enterprise performance? —From the perspective of public policy and innovation. *Journal of Innovation & Knowledge*, 7(3), pp. 190-198. <https://doi.org/10.1016/j.jik.2022.100198>
- 50) Rachinger, M., Rauter, R., Müller, C., Vorraber, W., & Schirgi, E. (2019). Digitalization and its influence on business model innovation. *Journal of Manufacturing Technology Management*, 30(8), pp. 1143-1160. <https://doi.org/10.1108/JMTM-01-2018-0020>.
- 51) Rao, W. & Zhang, Z. (2021). Key risks and development strategies for China's high-end medical equipment innovations. *Risk Management and Healthcare Policy*, 3037-3056. <https://doi.org/10.2147/RMHP.S306907>
- 52) Ren, C., Lee, S-J, & Hu, C. (2023). Digitalization improves enterprise performance: New evidence by text analysis. *SAGE Open*, DOI: 10.1177/21582440231175871
- 53) Scafarto, V., Dalwai, T., Ricci, F., & della Corte, G. (2023). Digitalization and firm financial performance in healthcare: The mediating role of intellectual capital efficiency. *Sustainability*, 15, 4031. <https://doi.org/10.3390/su15054031>
- 54) Shah, N., Zehri, A.W., Saraih, U.N., Abdelwahed, N.A.A. & Soomro, B.A. (2024). The role of digital technology and digital innovation towards firm performance in a digital economy. *Kybernetes*, 53(2), 620-644. <https://doi.org/10.1108/K-01-2023-0124>
- 55) Shanthana S; Gopal, V.; Navulla, D., Seal, S., Sohail, M.A., & Paul, G.A. (2023). Artificial intelligence assisted service marketing using deep assisted neural network, *International Conference on Research Methodologies in Knowledge Management, Artificial Intelligence and Telecommunication Engineering (RMKMATE), Chennai, India*, 1-5, doi: 10.1109/RMKMATE59243.2023.10368772.
- 56) Sharma, V., Poulouse, J., & Maheshkar, C. (2023). *Analytics enabled decision making tracing the journey from data to decisions*. In: Sharma, V., Maheshkar, C., Poulouse, J. (eds) *Analytics Enabled Decision Making*. https://doi.org/10.1007/978-981-19-9658-0_1
- 57) Solona, O., Skoromna, O., & Ohorodnichuk, H. (2023). Application of digital technologies in the field of animal husbandry. *Tehnika, Energetika, Transport APK*, doi: 10.37128/2520-6168-2023-4-5
- 58) Sun, L. & Wang, Y. (2022). Improving and evaluating business management in the digital economy based on data analysis. *Security and Communication Networks*, 9. <https://doi.org/10.1155/2022/5908877>
- 59) Tao, F., Wang, X. R., Xu, Y., & Zhu, P. (2023). Digital transformation, industrial chain and supply chain resilience, and enterprise productivity. *China's Industrial Economy*, (05), pp. 118-136. <https://doi.org/10.19581/j.cnki.ciejournal.2023.05.012>.
- 60) Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, 51(1), 40-49. doi:10.1016/j.lrp.2017.06.007
- 61) Thrassou, A., Uzunboylu, N., Vrontis, D., Christofi, M. (2020). Digitalization of SMEs: A Review of Opportunities and Challenges. *The Changing Role of SMEs in Global Business. Palgrave Studies in Cross-disciplinary Business Research*. https://doi.org/10.1007/978-3-030-45835-5_9
- 62) Verhoef, P., Broekhuizen, T., Bart, Y., Bhattacharya, A., et al. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, pp. 889-901. <https://doi.org/10.1016/j.jbusres.2019.09.022>.

- 63) Wu, Y., Li, H., Luo, R. and Yu, Y. (2023), How digital transformation helps enterprises achieve high-quality development? Empirical evidence from Chinese listed companies, *European Journal of Innovation Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/EJIM-11-2022-0610>
- 64) Wujarso, R. (2023). Effect of digital transformation on company operational efficiency. *Central European Management Journal*, 31(2), 136–142. <https://doi.org/10.57030/23364890.cemj.31.2.16>
- 65) Xie, J. (2024). Research on innovation and practice of corporate economic management in the digital economy era. *Advances in Economics and Management Research*, 10, pp 107-113. doi: 10.56028/aemr.10.1.107.2024
- 66) Xu, D.M., Wu Q., & Tao, C. Q. (2022). How the digital technology affects the high-quality development of the manufacturing industry. *Journal of Jiangxi Normal University (Natural Science Edition)*, (06), pp. 585-593. <https://doi.org/10.16357/j.cnki.issn1000-5862.2022.06.05>.
- 67) Xue, X. Y., & Liu, X. H. (2022). Digital Globalization, digital risks, and global digital governance. *The Northeast Asia Forum*, 31(03), 3-18. <https://doi.org/10.13654/j.cnki.naf.2022.03.001>
- 68) Xun, Y., Ye, Y., & Jia, B. (2022). Digital transformation and R&D innovation: The moderating effect of marketization degree. *BCP Business & Management*, 19, pages 316-328. <https://doi.org/10.54691/bcpbm.v19i.820>.
- 69) Yang, Y., & Han, J. (2023). Digital transformation, financing constraints, and corporate environmental, social, and governance performance. *Corporate Social Responsibility and Environmental Management*, 30(6), pages 3189-3202, <https://doi.org/10.1002/csr.2546>
- 70) Yu, J. Y., Wang, X., Zhang, W., & Li, Q. (2021). Overview of the digital transformation of the steel industry. *Iron Alloy*, (05), 44-48. <https://doi.org/10.16122/j.cnki.issn1001-1943.2021.05.012>.
- 71) Zhang, P., Zhang, P., Li, Z., & Sun D. (2024). Impact of enterprise digital transformation on the efficiency of total factor energy utilization: -- From the perspective of differences in enterprise energy efficiency. *Transactions on Economics, Business and Management Research*, 6, 276-291. <https://doi.org/10.62051/9bkkdk89>
- 72) Zhao, X., Chen, Qa., Yuan, X. & Zhang, H. (2024). Study on the impact of digital transformation on the innovation potential based on evidence from Chinese listed companies. *Science Report* 14, 6183. <https://doi.org/10.1038/s41598-024-56345-2>
- 73) Zheng, L., Wang, H., Xu, X., & Hung, T. (2022). Impact of financial digitalization on organizational performance: A look at the dark side. *Journal of Global Information Management* 30(1), pages 1–35. <https://doi.org/10.4018/JGIM.301602>
- 74) Zhou, Y., Yang, C., Liu, Z., & Gong, L. (2023). Digital technology adoption and innovation performance: a moderated mediation model. *Technology Analysis & Strategic Management*, 1–16. <https://doi.org/10.1080/09537325.2023.2209203>
- 75) Zhu, Y., Manansala, L., & Valeroso, E. (2024). Dynamic Relationship of Digital Transformation, Human Capital, Innovation, and Financial Performance in Chinese Manufacturing Firms. *Seybold Report Journal*, 19(5), pp. 484–505. <https://doi.org/10.5281/zenodo.11384408>