

The Impact of MIS Investment on the Technical Efficiency of SMEs Under Digital Transformation: Empirical Evidence from China's A-Share Small and Medium-Sized Listed Companies

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Abstract: Using the panel data of small and medium-sized board listed companies in China's A-share market from 2021 to 2024, this research applies the input-oriented DEA-BCC model to measure the technical efficiency at the company level and then adopts the industry-annual two-way fixed effects model to examine the influence of management information system investment on the technical efficiency of small and medium-sized enterprises. We find that the investment in the management information system significantly restrains the technical efficiency: an increase of one standard deviation in the investment intensity will lead to the efficiency decreasing by 0.0431 units, which is equivalent to 13.34% of the sample mean and this confirms that there is a productivity paradox in the digital transformation of small and medium-sized enterprises which is analogous to the classic Solow Paradox at the corporate level. This inhibitory effect is more obvious in small-scale, high-leverage, low-profitability companies, which shows that resource endowments and risk-resistance capabilities are indeed the key boundary conditions. This research not only provides micro-empirical evidence for the research regarding the digital transformation of small and medium-sized enterprises but also produces practical reference materials for enterprises and policymakers.

Keywords: MIS investment; Technical efficiency; Small and medium-sized enterprises (SMEs); Solow paradox; DEA model

Online publication: June 3, 2026

1. Introduction

1.1. Research background

The digital economy has already become the core engine of China's high-quality economic development, and the national policies clearly position the digital transformation of small and medium-sized enterprises as a key pillar for the upgrading of the real economy. Contributing to more than 50% of the national tax revenues,

60% of the GDP, 70% of the scientific and technological innovations, and 80% of the urban employment, the transformation effectiveness of China's small and medium-sized enterprises is of vital significance to the stability of a more extensive economic foundation.

As a core investment in the digital transformation of small and medium-sized enterprises the management information system (MIS) can in theory reduce costs and enhance efficiency by integrating business capital and information flows. However, many SMEs still face the practical dilemma that investment in management information systems does not immediately translate into efficiency improvement. Problems such as high implementation costs, weak organizational adaptation, and delayed returns remain common in SME digital transformation. The widespread dilemma of "investment exceeds effectiveness" highlights the "Solow Paradox", the separation between information technology investment and efficiency improvement, which is particularly evident in small and medium-sized enterprises ^[1]. Under such a background, the actual impact of the investment in management information systems on the technological efficiency of small and medium-sized enterprises is of significant theoretical and practical value to be explored.

1.2. Literature review and research gaps

Within the existing research on digital investment and enterprise efficiency, there exist two core perspectives that have been formed. The viewpoint of efficiency empowerment holds that digital investment can greatly enhance production efficiency through optimizing resource allocation and management; however, most relevant research focuses on large enterprises ^[2]. The viewpoint of the Solow paradox states that the efficiency improvement of digital investment has strict thresholds; if there are no supporting conditions such as sufficient scale and talent reserves, digital investment may not be able to promote efficiency improvement and may even have an inhibitory effect, which has been verified in the situation of listed enterprises in China ^[3].

This study identifies three core research gaps as follows:

- (1) Most research centers on large enterprises, with limited micro-level evidence specific to SMEs ^[4];
- (2) Core explanatory variables are mostly broad composite indicators of overall digital investment, lacking precise identification of MIS investment, a core sub-dimension of digital transformation;
- (3) Existing studies provide insufficient in-depth analysis of the heterogeneous boundaries of digital investment's effects, making it hard to explain the divergent transformation outcomes observed among SMEs.

1.3. Research content and marginal contributions

Taking China's A-share small and medium-sized board listed companies as samples, this research first measures the technical efficiency of enterprises by using the DEA-BCC model then tests the efficiency effect of MIS investment by using the two-way fixed effect model verifies the reliability of the conclusion through various robustness tests and finally analyzes the heterogeneous boundaries of the effect through group regression.

There are three aspects of our marginal contributions. Theoretically within the investment backdrop of management information systems in small and medium-sized enterprises, we verify the applicability of Solow's paradox supplement evidence in the micro dimension for the research on the digital transformation of small and medium-sized enterprises and also fill the sample gap in existing literatures. Empirically, we construct precise measurement indicators of management information system investment with detailed information of intangible assets identify its inhibitory effect on the technical efficiency of small and medium-sized enterprises and solve the problem of the relatively broad measurement limitations in previous researches ^[5]. In the practical aspect, the different moderating effects of enterprise resource endowments on the investment effects of management

information systems are clarified, thus providing targeted references for enterprises and policy-makers.

2. Theoretical basis and research hypotheses

2.1. Core theoretical foundations

2.1.1. Solow paradox

Solow first pointed out a puzzling trend: despite massive IT spending, productivity wasn't keeping pace. Later studies dug deeper and found that IT only boosts efficiency when paired with the right management practices, skilled staff, and organizational changes. If a company simply buys hardware and software without these supporting elements, resources get wasted, operating costs go up, and efficiency actually suffers. This idea runs through our entire study.

2.1.2. Resource-based view (RBV)

According to the resource-based view (RBV), it is that only the scarce, inimitable, irreplaceable, and heterogeneous resources can bring sustainable competitive advantages to enterprises ^[6]. Small and medium-sized enterprises face inherent limitations in their core resources, such as those in capital and talent. If the continuous investment in the management information system cannot be transformed into different competitive advantages, then the resources for core business activities like R&D and production upgrading will be squeezed out, thereby resulting in low efficiency of resource allocation and reducing the operational efficiency.

2.1.3. Theory of economies of scale

This theory holds that firms' long-run average costs decline as operating scale expands, with cross-business allocation of fixed costs as the core source of scale economies. As a typical fixed investment, MIS systems have a clear scale threshold for realizing efficiency gains: only when business volume reaches a certain level can firms fully leverage their information integration capabilities and amortize upfront fixed costs. SMEs' small operating scale and short business chains make it difficult to fully exploit the scale synergies of MIS systems, creating an inherent risk of low input-output ratios ^[7,8].

2.2. Research hypotheses

2.2.1. Main hypothesis

Building on the three theories above, we argue that SMEs' MIS investment has a significant inhibitory effect on technical efficiency, driven by three core mechanisms as follows:

- (1) Resource misallocation effect, where MIS investment crowds out SMEs' limited resources for core business operations;
- (2) Inadequate management adaptation: Most SMEs only complete hardware and software procurement without complementary management optimization and digital talent development, increasing operational complexity;
- (3) Scale threshold constraints, where SMEs' business volume is insufficient to support the scale effects of MIS systems, leaving fixed investment costs uncovered.

Accordingly, we propose:

H1: After controlling for other influencing factors, MIS investment by SMEs has a significant inhibitory effect on technical efficiency.

2.2.2. Heterogeneity hypotheses

From the perspective of firm resource endowment, we propose three heterogeneity hypotheses:

H2a: The inhibitory effect of MIS investment on technical efficiency is more significant for small-scale SMEs than for large-scale SMEs.

Smaller firms have more limited resource endowments and face greater difficulty in leveraging MIS scale effects, leading to more severe resource misallocation.

H2b: The inhibitory effect of MIS investment on technical efficiency is more significant for high-leverage SMEs than for low-leverage SMEs.

High-leverage firms face greater debt repayment pressure and more limited discretionary cash flow; MIS investment will further exacerbate their financial burden and amplify the negative effects of resource misallocation.

H2c: The inhibitory effect of MIS investment on technical efficiency is more significant for low-profitability SMEs than for high-profitability SMEs.

Low-profitability firms lack sufficient endogenous earnings to support MIS complementary construction and transformation trial-and-error costs, intensifying the negative impact of resource misallocation.

These predictions are consistent with recent work on the nonlinear impact of digitalization on SME performance ^[9,10].

3. Research design

3.1. Sample selection and data sources

We take China's A-share small and medium-sized listed firms from 2021 to 2024 as the initial sample, and apply the following screening criteria:

- (1) Excluding financial listed firms;
- (2) Excluding ST and *ST firms with abnormal operations;
- (3) Excluding samples with severe missing core variable data;
- (4) Winsorizing all continuous variables at the 1% level in both tails to eliminate extreme value interference.

Our final sample includes 4,972 firm-year observations. All financial and MIS investment-related data are sourced from the China Stock Market & Accounting Research (CSMAR) Database. The 2024 annual data used in this study are from the June 2025 annual update of the CSMAR Database, and all financial indicators are from audited annual reports of listed firms, ensuring data integrity and full comparability across the sample period. All data processing and empirical analysis are conducted using Python.

3.2. Variable definitions

3.2.1. Explained variable: Enterprise technical efficiency (eff_bcc)

We use an input-oriented DEA-BCC model to measure annual firm technical efficiency, which is well-suited to the larger scale disparities among our SME sample ^[11]. Input variables include net fixed assets, total operating cost, whereas output variables include operating revenue, net profit attributable to parent company shareholders. For the non-negative requirement of the DEA model, we set negative net profit values to 0 in the benchmark regression, which is a widely used processing method in existing DEA-related firm efficiency studies. We conduct annual cross-sectional DEA estimation, with efficiency values ranging from [0,1], where values closer to 1 indicate higher technical efficiency.

3.2.2. Core explanatory variable: MIS investment intensity (mis_w)

We construct a precise MIS investment index using detailed intangible asset data from the CSMAR Database:

We screen MIS-related intangible assets, including items with names containing “management system”, “MIS”, “ERP”, “office software”, “digital management platform”, “financial system”, “supply chain management system”, and “customer management system”, excluding non-MIS intangible assets such as patents, trademarks, land use rights, franchises, and R&D expenditures.

We aggregate the year-end balance of MIS-related intangible assets for each firm in each year, with the final measurement formula:

$$mis_w = \ln(\text{Annual ending balance of MIS-related intangible assets} + 1) \quad (1)$$

This method addresses the right-skewed distribution of non-negative financial variables and retains zero-investment samples. This study uses the year-end balance of MIS intangible assets instead of current new investment, because the value of MIS systems is amortized continuously, and their impact on firm efficiency is long-term, rather than limited to the current period.

3.2.3. Control variables

Following standard settings in existing firm efficiency research, this study selects five firm-level control variables as outlined:

- (1) Firm size (size_w), natural logarithm of year-end total assets;
- (2) Asset-liability ratio (lev_w), year-end total liabilities divided by year-end total assets;
- (3) Return on equity (roe_w), annual net profit divided by average net assets;
- (4) Firm age (age_w), natural logarithm of the firm’s listing years;
- (5) Ownership nature (soe), a dummy variable equal to 1 for state-owned enterprises and 0 otherwise.

3.2.4. Fixed effects

This paper controls for industry fixed effects (2012 Industry Classification Standard of the China Securities Regulatory Commission (CSRC), with secondary codes retained for manufacturing and primary codes used for other industries) and year fixed effects to alleviate the interference of inherent industry characteristics and annual macro shocks.

3.3. Model specification

To test the main hypothesis H1, this paper constructs an industry-year two-way fixed effects model, specified as follows:

$$eff_bcc_{i,t} = \alpha_0 + \alpha_1 mis_w_{i,t} + \sum \alpha_k Controls_{i,t} + \mu_{ind} + \lambda_t + \varepsilon_{i,t} \quad (2)$$

Where i represents the enterprise individual and t represents the year; $eff_bcc_{i,t}$ is the technical efficiency of the enterprise, $mis_w_{i,t}$ is the MIS investment intensity, $Controls_{i,t}$ is the set of control variables, μ_{ind} is the industry fixed effect, λ_t is the year fixed effect, and $\varepsilon_{i,t}$ is the random disturbance term.

This paper focuses on the coefficient α_1 . If α_1 is significantly negative, the main hypothesis H1 is established. All regressions use cluster-robust standard errors at the firm level to alleviate the problems of heteroscedasticity and serial correlation.

4. Empirical results and analysis

4.1. Descriptive statistics

Table 1 reports descriptive statistics for core variables. The mean technical efficiency of sample firms is only 0.323 (median 0.286), indicating that the overall technical efficiency of Chinese SMEs is at a low level, with significant efficiency disparities across firms. The distribution of MIS investment intensity is relatively concentrated, and sample firms have moderate debt levels and low overall profitability, consistent with the typical operating characteristics of SMEs and confirming the representativeness of our sample.

Figure 1 shows that the technical efficiency of the sample firms presents a right-skewed distribution. Most observations are concentrated in the low-efficiency interval of 0.2–0.3, while a small number of firms extend toward the efficiency frontier. This distribution is consistent with the descriptive statistics in Table 1, where the mean technical efficiency is 0.323 and the median is 0.286. Overall, the figure further indicates that the technical efficiency of Chinese SMEs remains relatively low and varies considerably across firms.

Table 1. Descriptive statistics of core variables

Variable name	Variable symbol	Observations	Mean	Std. Dev.	Minimum	Median	Maximum
Enterprise Technical Efficiency	eff_bcc	4972	0.323	0.137	0.026	0.286	1.000
MIS Investment Intensity	mis_w	4972	18.661	1.789	13.763	18.739	23.125
Firm Size	size_w	4972	22.212	1.389	19.446	22.163	25.975
Asset-Liability Ratio	lev_w	4972	0.408	0.185	0.066	0.402	0.870
Return on Equity	roe_w	4972	0.049	0.127	-0.593	0.066	0.302

Note: Sample period 2021–2024. All continuous variables are winsorized at the 1% level in both tails. Data Source: CSMAR Database.

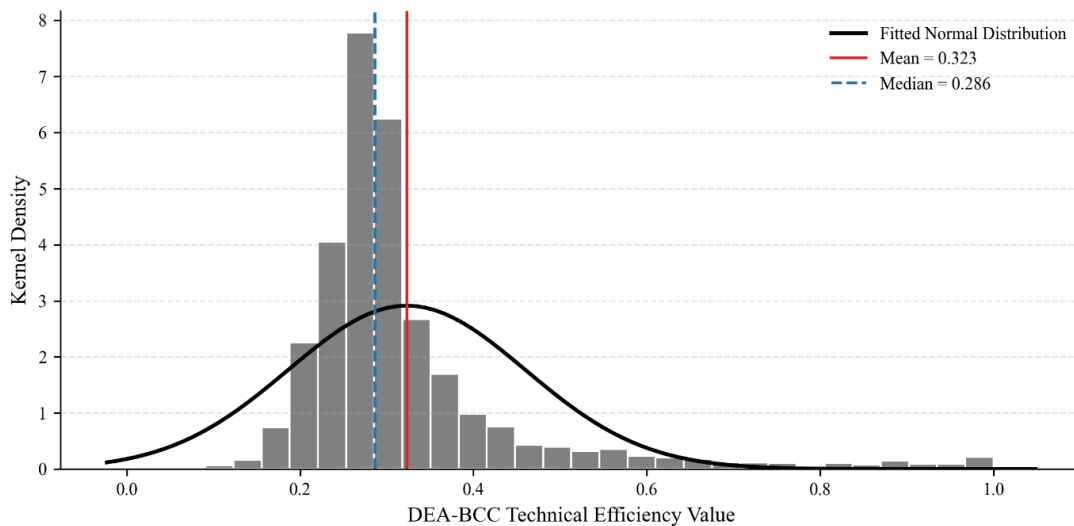


Figure 1. Distribution of technical efficiency of SMEs. **Note:** The horizontal axis represents the annual technical efficiency of enterprises measured by the DEA-BCC model, and the vertical axis represents kernel density. The red solid line indicates the full-sample mean value of technical efficiency (0.323), the blue dashed line indicates the full-sample median value (0.286), and the black solid line represents the fitted normal distribution curve. Data Source: CSMAR Database.

4.2. Correlation and multicollinearity test

The Pearson correlation coefficient between MIS investment intensity and firm technical efficiency is -0.190, significantly negative at the 1% level, consistent with the expected direction of H1 and preliminarily verifying the negative correlation between MIS investment and SMEs' technical efficiency. All VIF values are well below the 10 threshold, ruling out severe multicollinearity in the model (**Table 2**).

Table 2. Multicollinearity VIF test results

Variable name	Variable symbol	VIF value	Test conclusion
MIS Investment Intensity	mis_w	3.218	No severe multicollinearity
Firm Size	size_w	3.583	No severe multicollinearity
Asset-Liability Ratio	lev_w	1.463	No severe multicollinearity
Return on Equity	roe_w	1.141	No severe multicollinearity
Firm Age	age_w	1.087	No severe multicollinearity
Ownership Nature	soe	1.072	No severe multicollinearity

Note: A VIF value less than 10 is the academic criterion for judging the absence of severe multicollinearity.

4.3. Analysis of benchmark regression results

This study adopts a progressive regression strategy to verify the core hypothesis, with results reported in **Table 3**. Model 1 is a single-variable regression that only has the core explanatory variable. Model 2 includes all the firm-level control variables. Model 3 brings in industry fixed effects. Model 4, which is the core benchmark model, controls the two-way fixed effects of both industry and year in order to reduce endogeneity that comes from omitted variables.

As shown in **Table 3**, the coefficient of the investment intensity of MIS is negative zero. In Model 1, it is significantly negative at the 1% level, initially verifying the negative correlation between the investment in management information systems and the technical efficiency of small and medium-sized enterprises. When adding control variables and fixed effects, this negative effect remains stable and significant at the 1% level in Models 2 to 4.

Taking Model 4 as the benchmark result, the coefficient of MIS investment intensity is -0.0241 and remains significant at the 1% level. In economic terms, a one-standard-deviation increase in MIS investment intensity, 1.789, is associated with a 0.0431-unit decrease in technical efficiency, which is approximately 13.34% of the sample mean. Therefore, H1 is supported. This result is consistent with the logic of the classic Solow paradox at the firm level.

Table 3. Benchmark regression results

Variable name	(1) Univariate regression	(2) With control variables	(3) With industry FE	(4) Two-way fixed effects
MIS Investment Intensity	-0.0146*** (0.0031)	-0.0282*** (0.0041)	-0.0251*** (0.0040)	-0.0241*** (0.0039)
Firm Size	—	0.0222*** (0.0061)	0.0185*** (0.0061)	0.0172*** (0.0061)
Asset-Liability Ratio	—	-0.0259 (0.0201)	-0.0387** (0.0183)	-0.0412** (0.0182)
Return on Equity	—	0.2740*** (0.0244)	0.2681*** (0.0239)	0.2666*** (0.0238)
Firm Age	—	-0.0126** (0.0058)	-0.0108* (0.0058)	-0.0112* (0.0058)
Ownership Nature	—	0.0087 (0.0091)	0.0072 (0.0090)	0.0069 (0.0090)
Constant Term	0.5951*** (0.0575)	0.3533*** (0.0934)	0.3487*** (0.1012)	0.3620*** (0.1018)

Control Variables	Not Controlled	Controlled	Controlled	Controlled
Industry Fixed Effects	Not Controlled	Not Controlled	Controlled	Controlled
Year Fixed Effects	Not Controlled	Not Controlled	Not Controlled	Controlled
Firm-Year Observations	4972	4972	4972	4972
Adjusted R ²	0.035	0.212	0.224	0.227

Note: The explained variable is the annual technical efficiency of enterprises measured by the DEA-BCC model. Values in parentheses are cluster-robust standard errors at the firm level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. “-” indicates that the variable is not included in the corresponding model.

The regression outcomes of controlling variables are in line with theoretical expectations: the coefficients of enterprise scale and return on net assets are significantly positive, which shows that scale economy and profitability are key driving factors for the enhancement of the technological efficiency of small and medium-sized enterprises; the coefficients of asset-liability ratio and enterprise age are significantly negative, which suggests that the financial pressure of high leverage and the operational inertia after the mature period may impede technological efficiency.

5. Robustness tests and heterogeneity analysis

5.1. Robustness tests

To confirm the dependability of the core findings, this paper makes use of six methods to carry out robustness tests. All the test results are documented in **Table 4**, and the core conclusions have been all along quite stable indeed.

Table 4. Summary of robustness test results

Test no.	Test method	Core explanatory variable	Coefficient	Std. error	Significance	Consistency with benchmark conclusion
1	One-period lag of the core explanatory variable	mis_w _{t-1}	-0.0218	0.0042	***	Fully consistent
2	Replacement of explained variable (DEA-CRS comprehensive technical efficiency)	mis_w	-0.0227	0.0041	***	Fully consistent
3	Replacement of core explanatory variable (current new MIS investment)	mis_new	-0.0203	0.0040	***	Fully consistent
4	Adjustment of winsorization level (1%→5%)	mis_w	-0.0235	0.0038	***	Fully consistent
5	Replacement of econometric model (firm-year two-way fixed effects)	mis_w	-0.0198	0.0045	***	Fully consistent
6	Exclusion of loss-making samples	mis_w	-0.0229	0.0040	***	Fully consistent

Note: All regressions include the same control variables and fixed effects as the benchmark model. Standard errors are reported in the “Std. error” column and are clustered at the firm level. *** $p < 0.01$. The DEA-CRS model uses the same input and output indicators as the benchmark DEA-BCC model, with only the returns-to-scale assumption changed.

This research carries out a regression of the investment intensity of the management information system with a one-period lag on technical efficiency so as to relieve potential reverse causality. It replaces the explained variable with the DEA-CRS comprehensive technical efficiency where the input-output indicators remain unchanged. Moreover, this research takes the natural logarithm of the current new MIS intangible assets as the core explanatory variable which avoids the stock-flow confusion problem of the year-end balance index and the results are consistent. It adjusts the winsorization level of all continuous variables from 1% to 5% and makes use of a fixed annual two-way fixed effects model to control the company characteristics that do not change with time.

In order to address the possible efficiency distortion issue brought about by setting negative net profit as 0 in the benchmark regression, we exclude all the annual observations of companies having negative net profits and re-estimate the model. This test completely gets rid of the interference of negative output values on DEA efficiency measurement, and the coefficient of MIS investment intensity is still significantly negative at the 1% level, which is completely in line with the benchmark conclusion. This has confirmed that our core findings will not be affected by the ways of dealing with the negative outputs.

5.2. Heterogeneity analysis

In order to further explore the boundary conditions of the investment effect of the management information system we carried out the grouped regression according to the company scale leverage level and profitability and the result is reported in **Table 5**. The grouping criteria are based on the annual median of the whole sample, and then the significance of the coefficient differences is verified through the Fisher permutation test with 1000 times of sampling repetitions.

Table 5. Heterogeneity analysis results

Variable name	(1) Small-scale Enterprises	(2) Large-scale Enterprises	(3) High-leverage Enterprises	(4) Low-leverage Enterprises	(5) Low-profitability Enterprises	(6) High-profitability Enterprises
MIS Investment Intensity	-0.0312*** (0.0052)	-0.0125* (0.0067)	-0.0357*** (0.0058)	-0.0108 (0.0056)	-0.0386*** (0.0055)	-0.0087 (0.0059)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry + Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year Observations	2485	2487	2486	2486	2485	2487
Adjusted R ²	0.218	0.235	0.209	0.241	0.198	0.252

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Values in parentheses are firm-level cluster-robust standard errors. The P -values of coefficient differences between groups are 0.021 (firm size), 0.003 (leverage), and < 0.001 (profitability), all statistically significant at the 5% level or below.

There are differences in the scale of enterprises, where the coefficient of MIS investment intensity is negative zero. For the small-scale group it is -0.0312 at the 1% significance level and for the large-scale group it is -0.0125 at the 10% significance level and the difference in coefficients is significant at the 5% level with $P = 0.021$. Therefore, H2a is supported. This finding directly confirms the scale threshold constraint

mechanism within the main hypothesis, which shows that small-sized companies are not able to completely spread out the fixed costs of management information systems and also fail to exert their scale synergy effects.

Furthermore, the utilization of differences is carried out, where the coefficient is negative. For the high-leverage group, it is -0.0357 at the 1% significance level, while for the low-leverage group, it is not statistically significant, and the difference in coefficients is significant at the 1% level with $P = 0.003$, where H2b is supported. This result accords with the resource misallocation mechanism, enterprises with high leverage encounter stricter financial constraints, and the investment in MIS further crowds out the resources of core businesses, making the inhibitory effect indeed more severe.

It is the situation of the difference in profitability: the coefficient is negative. For the low-profit group, it is -0.0386 (at the 1% significance level), while for the high-profit group, it is not statistically significant, and the difference in coefficients is significant at the 1% level ($P < 0.001$). Thus, H2c is supported. This result also confirms the resource misallocation mechanism: the companies of low profitability do not have sufficient internal returns to support the complementary construction of the management information system, thereby making the negative impact of investment more serious.

Generally speaking, the inhibitory effect of MIS investment on the technological efficiency of small and medium-sized enterprises has obvious heterogeneous boundaries the negative effect will become weaker as the enterprise scale increases the leverage decreases and the profitability improves. The key boundary conditions for relieving the “Solow Paradox” of digital transformation are in the enterprise resource endowments and risk-resisting capabilities of small and medium-sized enterprises.

6. Research conclusions and implications

6.1. Core research conclusions

Based on 2021–2024 panel data of China’s A-share small and medium-sized listed firms, this study evaluates firm-level technical efficiency with an input-oriented DEA-BCC model, and identifies the impact of MIS investment on SME efficiency via an industry-year two-way fixed effects framework. Three core findings are derived as follows.

The overall technical efficiency of Chinese SMEs remains at a low level. The full-sample efficiency averages 0.323, with more than half of the firms scoring below 0.3, and there are notable gaps in efficiency performance across the sample.

Additionally, MIS investment has a significant inhibitory effect on the technical efficiency of SMEs. A one-standard-deviation rise in MIS investment intensity reduces firm efficiency by 0.0431 units, equivalent to 13.34% of the sample mean. This finding validates the firm-level digital productivity paradox among Chinese SMEs, which aligns with the core logic of the classic Solow Paradox, and holds robust across a battery of robustness checks.

Finally, the efficiency impact of MIS investment has clear heterogeneous boundaries. The inhibitory effect is significantly more pronounced in SMEs with smaller scale, higher leverage, and lower profitability, while it weakens and even becomes statistically insignificant among firms with stronger resource endowments and anti-risk capabilities.

6.2. Theoretical contributions

This research has made three key contributions in regard to the existing literature. First of all, it verifies the

applicability of Solow's paradox in the investment situation of small and medium-sized enterprise. Management information systems supplements micro-empirical evidence for the research on the digital transformation of small and medium-sized enterprises, and also fills the sample gap in the existing literature by mainly focusing on large enterprises. Moreover, it constructs a refined management information system investment measurement index with detailed intangible asset data, accurately identifying the inhibitory effect of this core digital transformation sub-dimension on the efficiency of small and medium-sized enterprises and solves the limitations of the broad and non-specific digital investment indicators in previous studies. Finally, it clearly defines the heterogeneous boundaries of the investment efficiency effect of the management information system, and provides new empirical evidence for understanding the non-linear characteristics of the impact of digital transformation on enterprise performance.

6.3. Practical implications

At the enterprise level, SMEs need to abandon blind MIS investment, match digital transformation with their business scale and resources, and prioritize lightweight MIS modules integrated with core operations. For those with weaker resource endowments, they should first stabilize core business profitability and cash flow, then gradually increase MIS investment as conditions improve.

From a policy perspective, the government should lower digital transformation thresholds through subsidies, tax preferences, and low-interest loans, while building public service platforms that offer low-cost MIS modules, consulting, and training. It also needs to guide service providers to develop lightweight, low-cost MIS products for SME scenarios and promote replicable benchmark cases across industries and scales.

6.4. Limitations and future research

Two limitations stand out. First, the transmission mechanisms were not tested, like resource misallocation or rising management costs, using a mediation model. The average effects and boundary conditions were not overlooked. Following that, our sample is limited to listed SMEs, so the conclusions might not be applicable to smaller, unlisted firms.

Future research could fill these gaps. One direction is to run mediation models to uncover the internal mechanisms, whereas another direction is to bring in survey or field data on unlisted SMEs, which would broaden the sample and improve generalizability.

Disclosure statement

The author declares no conflict of interest.

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