Online-Journals.org

iTDAF IETI Transactions on Data Analysis and Forecasting

iTDAF | eISSN: 2959-0442 | Vol. 3 No. 1 (2025) | OPEN ACCESS

https://doi.org/10.3991/itdaf.v3i1.55021

PAPER

Does the Capital Structure Affect the Digital Transformation of Enterprises? Mediating Role Based on Financing Costs

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ABSTRACT

With the rapid advancement of the digital economy, enterprises are increasingly leveraging digital transformation as a key driver of high-quality development. Despite its strategic importance, systematic research on how capital structure influences digital transformation remains limited. Drawing on data from listed companies in A-share manufacturing industries from 2009 to 2021, this study employs empirical analysis to explore the impact of asset-liability ratios on digital transformation. Findings indicate that a higher asset-liability ratio significantly accelerates the digital transformation process in manufacturing enterprises. Under debt financing pressure, firms tend to enhance production efficiency and reduce operational costs through digital technologies, thereby strengthening competitiveness and solvency. Moreover, financing costs play a crucial mediating role in the relationship between asset-liability ratios and enterprise digitization. A higher debt burden compels businesses to seek digital solutions for improving efficiency and profitability, mitigating financial risks in the process. This study not only deepens the understanding of key factors influencing digital transformation but also provides empirical support for optimizing corporate capital structures and shaping digital development strategies.

KEYWORDS

asset-liability ratio, digital transformation, financing cost, manufacturing enterprises

1 INTRODUCTION

With the rapid advancement of the digital economy, digitalization has become a crucial strategy for enhancing the competitiveness of the global manufacturing sector. By optimizing industrial structures and fostering high-quality development, digital transformation has not only reshaped production methods and business models but also fundamentally redefined the value chain and competitive landscape of the manufacturing industry. In China, the 14th Five-Year Plan explicitly emphasizes

Kun, Z. (2025). Does the Capital Structure Affect the Digital Transformation of Enterprises? Mediating Role Based on Financing Costs. *IETI Transactions on Data Analysis and Forecasting (iTDAF)*, 3(1), pp. 4–17. https://doi.org/10.3991/itdaf.v3i1.55021

Article submitted 2025-01-19. Revision uploaded 2025-03-08. Final acceptance 2025-03-12.

the importance of accelerating industrial digitalization, building a modern industrial system, and prioritizing the intelligent upgrading of the manufacturing sector. Intelligent Manufacturing Development, issued by the State Council, states that intelligent manufacturing should make full use of digital technologies such as artificial intelligence, big data, cloud computing, and the Internet of Things to improve the level of intelligence of enterprises and enhance the resilience and security of the industrial chain and supply chain. In recent years, the state has issued a series of intensive policies to promote the development of manufacturing enterprises in the digital and intelligent direction. For example, the Intelligent Manufacturing Development Plan (2016–2020) released by the Ministry of Industry and Information Technology clearly stated that by 2025, China will basically realize the digital transformation and build a group of world-leading intelligent manufacturing enterprises. In addition, it stressed that enterprises should increase investment in technological innovation, improve their digital management capabilities, and realize the transformation and upgrading from traditional manufacturing to intelligent manufacturing. Under the guidance of these policies, Chinese manufacturing enterprises are accelerating the pace of digital transformation to meet the needs of competition and industrial upgrading.

Although the policy level has clearly supported the digital transformation of the manufacturing industry, it still faces many challenges, among which financing constraints and capital structure issues are particularly critical. Manufacturing enterprises usually need a lot of capital investment in digital upgrading, including purchasing advanced equipment, building intelligent production lines, and researching and developing new technologies. However, digital transformation involves significant risks, substantial costs, and a long return cycle. Relying solely on internal funds often proves challenging for enterprises to fully meet transformation demands, making external financing a crucial funding source. In this context, the capital structure of enterprises, especially the asset-liability ratio, may have an important impact on the digital transformation. On the one hand, some studies believe that the high asset-liability ratio may inhibit the technological innovation and digital investment of enterprises, because the high debt level may lead to increased financial pressure, thus reducing the risk-bearing ability and innovation willingness of enterprises. On the other hand, some studies have pointed out that moderate debt financing can play an intermediary role and promote the digital upgrading of enterprises. Debt pressures may prompt companies to enhance profitability through technological innovation and productivity improvements to improve their solvency. In addition, as an important variable of capital structure, financing cost may play an intermediary role between the asset-liability ratio and digital transformation; that is, the high asset-liability ratio may lead to the rise of financing cost of enterprises, thus affecting their digital investment decisions.

This paper hopes to answer the following research questions: How does the asset-liability ratio affect the digital transformation of enterprises? Do financing costs play an intermediary role between the asset-liability ratio and the digital transformation of enterprises? The structure of this paper is as follows: Section 2 reviews relevant literature, sorts out the theoretical relationship between capital structure, financing cost, and digital transformation of enterprises, and puts forward research hypotheses. Section 3 introduces the research methods, including the data source, variable definition, measurement model, etc. Section 4 conducts empirical analysis to test the impact of the asset-liability ratio on the digital transformation of enterprises and further explore the intermediary role of financing cost and the regulating role of enterprise nature. Section 5 discusses the research conclusions and puts forward the policy suggestions. Finally, Section 6 provides a summary.

2 LITERATURE REVIEW AND RESEARCH HYPOTHESES

2.1 Capital structure

Capital structure plays a crucial role in corporate financial decision-making, and its optimal allocation significantly impacts a company's long-term growth. A key indicator within capital structure is the asset-liability ratio, which measures the extent of corporate debt financing. Modigliani and Miller (1958) introduced the "irrelevance theory" under a no-tax assumption, asserting that a firm's capital structure does not influence its value [1]. This theory established the foundation for modern capital structure research. According to agency theory, capital structure shapes managerial decision-making, as higher debt levels can restrict management discretion, thereby lowering agency costs and enhancing operational efficiency (Jensen, 1986) [2]. However, excessive debt may also create conflicts of interest between shareholders and creditors, potentially impacting corporate investment and innovation strategies (Harris and Raviv, 1991) [3].

2.2 Digital transformation of enterprises

Digital transformation is a strategic approach for enterprises to leverage digital technologies to redefine business models, streamline production processes, and strengthen competitiveness (Vial, 2019) [4]. In the manufacturing sector, it primarily involves the deep integration of intelligent manufacturing, industrial Internet, big data analytics, artificial intelligence (AI), blockchain, and other advanced technologies (Xu et al., 2021) [5]. In recent years, the global manufacturing industry has been rapidly evolving toward greater intelligence, connectivity, and digitalization to enhance efficiency, lower costs, and improve market competitiveness (Kane et al., 2015) [6]. Research indicates that multiple factors influence enterprise digital transformation. Foremost among them is technological advancement, with innovations such as AI playing a pivotal role in accelerating the digitalization of manufacturing (Schroeder et al., 2020) [7]. Secondly, the changes in the external market environment, such as personalized consumer demand, intelligent supply chains, and the rise of digital platforms, also promote manufacturing enterprises to accelerate the digital transformation (Zhao et al., 2022) [8]. In addition, policy support is also a driving force for digital transformation, especially in China, where policies such as "Made in China 2025," The Industrial Internet Action Plan and other policies provide the technical foundation and strategic direction for manufacturing enterprises (Li, 2021) [9]. The relationship between the capital structure, especially the asset-liability ratio, and the digital transformation of enterprises has gradually attracted more attention. On the one hand, reasonable debt financing can provide financial support for enterprises and promote the application of intelligent manufacturing technology. On the other hand, the excessively high asset-liability ratio may increase the financial pressure on enterprises, make them face greater operational risks, and then affect the long-term technology investment and innovation.

2.3 Capital structure and digital transformation of manufacturing industry

Enterprise innovation requires substantial capital investment; however, the high uncertainty of innovation projects makes external financing constraints a significant barrier to innovation (Hall and Lerner, 2010) [10]. Some studies have found that high asset-liability ratios may inhibit input and innovation output (Aghion et al., 2004) [11],

because financial pressures from debt financing may lead companies to prefer short-term investment rather than long-term innovation. However, some studies have pointed out that moderate debt financing can encourage enterprises to enhance their innovation capacity to improve their market competitiveness (Zhang et al., 2021) [12]. Enterprise investment decisions are greatly influenced by the capital structure. The balance theory is that debt financing can improve the efficiency of capital use, but excessive debt levels may lead to problems (Myers, 1977) [13]. A high asset-to-liability ratio may cause enterprises to reduce investment due to financial constraints, especially in an economic downturn; enterprises may reduce capital expenditure due to debt pressure (Graham et al., 2015) [14]. However, digital transformation has the characteristics of high investment and high risk, so the financing ability of an enterprise is crucial to its digital transformation strategy. Some studies have found that higher debt-to-asset ratios may prompt companies to accelerate their digital transformation to improve productivity and reduce operating costs (Chen and Liu, 2022) [15]. In addition, financing costs may play an intermediary role between the asset-liability ratio and digital transformation, and higher financing costs may force enterprises to seek to improve operational efficiency through digital means (Zhao et al., 2023) [8]. The following hypothesis is therefore proposed:

H1: The high asset-liability ratio promotes the digital transformation of manufacturing enterprises.

2.4 Intermediation role of financing cost

Financing cost refers to the fund use expenses paid by enterprises in the process of obtaining external funds, including interest expenditure, equity financing cost, debt financing cost, etc. Higher financing costs impose a greater financial burden on enterprises, impacting their investment choices, innovation efforts, and long-term growth strategies (Myers and Majluf, 1984) [16]. The asset-liability ratio is closely related to the financing cost of enterprises (Titman and Wessels, 1988) [17]. Higher financing costs may prompt companies to seek higher operational efficiencies to reduce capital pressure (Aghion et al., 2004) [18]. In recent years, some studies have found that when facing high financing costs, enterprises are more inclined to improve production efficiency and optimize business processes through digital means so as to reduce operating costs and improve profit margin (Guo and Xu, 2023) [19]. The impact of financing costs on enterprise risk management: Rising financing costs usually prompt enterprises to adjust their financial strategies, such as reducing short-term liabilities, optimizing debt structure, or increasing the proportion of their own capital (Frank and Goyal, 2009) [20]. The following hypothesis is therefore proposed:

H2: Asset-liability ratio promotes the digital transformation of the manufacturing industry through financing costs.

3 STUDY DESIGN

3.1 Study sample and data sources

This paper focuses on China's A-share manufacturing listed companies in 2009–2021 and deals according to the following principles: excluding the samples

of ST and PT listed companies, the samples of insurance listed companies, and the samples of missing related variables. Finally, 17,300 observations were obtained. The company's financial data is mainly derived from the Wind financial database and Guotai'an (CSMAR) database. To control for the effect of extreme values, Winsorize at the 1% level for all continuous variables.

3.2 Model setting

The following models are built based on the study assumptions:

$$datatrs_t = \alpha_0 + \alpha_1 assetlr_t + \alpha_2 controls_t + \sum year + \varepsilon_t \quad (1)$$

$$COD1_t = \beta_0 + \beta_1 assetlr_t + \beta_2 controls_t + \sum year + \varepsilon_t \quad (2)$$

$$datatrs_t = \gamma_0 + \gamma_1 assetlr_t + \gamma_2 COD1_t + \gamma_2 controls_t + \sum year + \varepsilon_t \quad (3)$$

The year represents the time fixed effect, $datatrs_t$ represents the degree of digital transformation, $assetlr_t$ represents the asset-liability ratio, $COD1_t$ represents the financing cost, ε_t represents the random disturbance term, and the model subscript t indicates the year.

3.3 Variable measure

The explained variable. Drawing on the practice of Wu Fei and others [21], this paper measures the frequency of digital words in the annual reports of listed companies after taking natural logarithms to measure the degree of digital transformation of listed companies. The digital word database and frequency were obtained from the CSMAR database.

The explanatory variables. The asset-liability ratio (assetlr) is calculated as the percentage of total liabilities relative to total assets. A higher asset-liability ratio indicates that a company relies more on debt financing relative to its assets. This suggests higher financial leverage, which can amplify both risks and returns. Companies with high leverage may face greater financial pressure due to debt repayment obligations and interest costs, potentially impacting their investment and operational strategies. A lower asset-liability ratio suggests that a company has a more conservative capital structure with a greater reliance on equity financing. While this reduces financial risk, it may also limit growth opportunities if external financing is not sufficiently utilized.

Mediation variables. Since A-share listed companies do not disclose detailed interest expenses for each type of debt contract, accurately calculating corporate debt financing costs is challenging. To minimize measurement bias, this paper follows the approach of Wang et al. [22] and employs two indicators. The first measure (COD1) represents the ratio of corporate interest expenses to total long- and short-term debt. In addition to interest payments, enterprises also incur other financial costs, such as bank fees, during the debt financing process. The second measure (COD2) captures the proportion of total financial expenses relative to long- and short-term debt.

Control Variables. Following the methodology of Wu Fei et al. [21] and Wang et al. [22], this paper incorporates a series of enterprise characteristic variables

into the model to control for factors that may influence digitalization. These variables include:

- Enterprise size (size1): Represented by the natural logarithm of total assets.
- Enterprise age (age): Calculated as the difference between the observed year and the founding year.
- Proportion of tangible assets (Rtangiblea): Measured as the percentage of tangible assets relative to total assets.
- Executive shareholding ratio (shareholding): Defined as the percentage of executive holdings in total outstanding shares.
- Dual role (dual): Assigned a value of 1 if the chairman and general manager are the same person; otherwise, 0.
- Ownership structure (stateowned): Coded as 1 for state-owned enterprises and 0 for non-state-owned enterprises.

4 EMPIRICAL RESULTS AND ANALYSIS

4.1 Descriptive statistics

According to Table 1 statistical results, the average degree of digital transformation (datatrs) is 7.459, which shows that most of the digital transformation degree is low, and the frequency of digital transformation-related words, the standard difference of 22.557, the minimum value of 0, and the maximum of 467 show that some enterprises did not carry out the digital transformation, while others are outstanding in terms of digital. The average asset-liability ratio (assetlr) is 0.424, reflecting that the general debt level of enterprises is about 42.4%, and the standard deviation is 0.184, indicating that the debt ratio of most enterprises is concentrated in a similar range. The minimum value is 0.007, and the maximum value is 0.997, indicating that there are enterprises with almost zero liabilities, and there are also enterprises with liabilities close to 100%.

Table 1. Descriptive statistics of the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
datatrs	17300	7.459	22.557	0	467
assetlr	17300	0.424	0.184	0.007	0.997
COD1	17300	0.021	0.015	0	0.066
Rtangiblea	17300	0.977	0.029	0.451	1
dual	17300	0.278	0.448	0	1
age	17300	9.93	6.437	2	31
size1	17300	22.108	1.163	19.098	27.547
stateowned	17300	0.344	0.475	0	1
shareholding	17300	13.464	19.613	0	89.725

Variable correlation coefficient results show that the asset-liability ratio (assetlr) and corporate debt financing cost (COD1) are significantly related, and there is a weak correlation with enterprise digital transformation (datatrs). At the same time, the financing cost is significantly related (COD1) to enterprise digital transformation

(datatrs), showing that the cost of financing is between the asset-liability ratio and enterprise digital transformation. The variance inflation factor (VIF) of the regression model was below 10, and the average VIF was 1.40, indicating a small multicollinearity problem and robust results.

4.2 Benchmark regression results

The regression results indicate a significant positive relationship between the asset-liability ratio (assetlr) and enterprise digital transformation (datatrs). In column 2, the regression coefficient is 6.717, with a t-value of 5.895, and is statistically significant at the 1% level ($p < 0.01$). This suggests that a higher asset-liability ratio corresponds to a greater degree of digital transformation. This supports the core assumption of this paper that companies under higher debt financing pressures prefer to improve productivity and profitability through digital transformation to enhance competitiveness and solvency. Besides, the regression results of other control variables also provided meaningful findings: Enterprise size (size1) and enterprise age (age) had a significant positive impact on digital transformation. It shows that enterprises with large scale and long establishment time have more resources and ability to promote digital upgrading. The proportion of tangible assets (Rtangiblea) is significant and positive. It indicates that enterprises with heavy asset structures may be more inclined to optimize operation and management through digital means. It indicates that companies with higher executive holdings are more conservative and unwilling to bear the uncertainty and risks of digital transformation. The state-owned enterprise (state-owned) and two-duty (dual) variables failed the significance test. It indicates that the nature of enterprise ownership and governance structure on digital transformation may be weak or have a more complex mechanism. From the perspective of the explanatory power of the model, the R^2 value (0.099) shows that the model can explain 9.9% of the enterprise digital transformation variation, which although not high, is common in similar enterprise research, as digital transformation is affected by many other factors. At the same time, the F value (230.920) at the 1% significance level indicates that the overall model has good explanatory power. In addition, after adding the asset-liability ratio variable, R^2 increased from 0.096 to 0.099, which further indicates that the asset-liability ratio has an enhanced ability to explain the digital transformation, and the regression results were generally robust. Therefore, the benchmark regression results support the research hypothesis that a high asset-liability ratio significantly promotes the digital transformation of enterprises, indicating that under debt financing pressure, enterprises may be more inclined to improve operational efficiency through digital transformation to enhance their solvency and competitiveness.

Table 2. Influence of asset-liability ratio on the digital transformation of enterprises

	(1)	(2)
	datatrs	datatrs
Rtangiblea	23.100***	24.429***
	(4.263)	(4.510)
dual	–0.311	–0.276
	(–0.798)	(–0.711)

(Continued)

Table 2. Influence of asset-liability ratio on the digital transformation of enterprises *(Continued)*

	(1)	(2)
	datatrs	datatrs
age	0.489***	0.539***
	(9.932)	(10.810)
size1	3.505***	2.965***
	(11.939)	(9.651)
stateowned	1.260	1.066
	(1.482)	(1.254)
shareholding	–0.115***	–0.107***
	(–7.456)	(–6.863)
assetlr		6.717***
		(5.895)
_cons	–96.239***	–89.010***
	(–12.762)	(–11.663)
N	17300	17300
R^2	0.096	0.099
F	263.014	230.920

4.3 Mediation effect test

Table 3 demonstrates that financing costs (COD2) serve as a partial mediator between the asset-liability ratio (assetlr) and enterprise digital transformation (datatrs). In the first regression step (column 1), the asset-liability ratio has a regression coefficient of 0.021 for financing costs, with a t-value of 22.182, and is statistically significant at the 1% level ($p < 0.01$). This indicates that a higher asset-liability ratio leads to increased corporate debt financing costs, aligning with expectations, as highly leveraged firms typically encounter greater financial pressure. Secondly, in the second step of regression (column 2), the direct impact of the asset-liability ratio on the digital transformation is still significant, with the regression coefficient of 6.342, which is significant at the 1% significance level ($t = 5.476$), which further supports the positive promotion effect of the asset-liability ratio. At the same time, the regression coefficient of financing cost (COD2) on digital transformation is 18.280, which is significant at the 10% significance level ($p < 0.1$) ($t = 1.803$), indicating that the rising financing cost has a certain positive role in promoting digital transformation. Control variables, the impact of enterprise size (size1) and enterprise age (age) on digital transformation, remain significant and positive. It shows that larger enterprises and enterprises with a long history have stronger ability and power in digital transformation. The proportion of tangible assets (Rtangiblea) has a negative impact on financing costs, indicating that enterprises with a higher proportion of tangible assets have lower financing costs. Its impact on the digital transformation is still significantly positive; the executive shareholding ratio (shareholding) has a significant negative impact on both financing costs and digital transformation, which may suggest that companies with higher executive

holdings are more conservative in decision-making and unwilling to take on the risk of a digital transformation. In general, the improvement of the asset-liability ratio not only directly promotes the digital transformation of enterprises but also further promotes the digital transformation of enterprises through the intermediary path of rising financing costs so as to reduce operating costs and improve profitability so as to relieve financial pressure. This shows that the financing cost plays a partial intermediary role in the process of the asset-liability ratio affecting the digital transformation of enterprises and further enriches the research on the influence mechanism of the digital transformation of enterprises.

Table 3. Asset-liability ratio, financing cost and digital transformation of enterprises

	(1)	(2)
	COD2	datatrs
assetlr	0.021***	6.342***
	(22.182)	(5.476)
Rtangiblea	–0.018***	24.754***
	(–4.049)	(4.567)
dual	0.000	–0.278
	(0.234)	(–0.714)
age	–0.000**	0.541***
	(–2.048)	(10.840)
size1	–0.001***	2.982***
	(–3.791)	(9.703)
stateowned	–0.000	1.071
	(–0.400)	(1.260)
shareholding	–0.000***	–0.106***
	(–4.798)	(–6.787)
COD2		18.280*
		(1.803)
_cons	0.052***	–89.966***
	(8.451)	(–11.761)
N	17300	17300
R^2	0.039	0.099
F	85.997	202.493

4.4 Robustness test

In order to test the robustness of the research results, this paper replaces the intermediary variable from COD1 (proportion of interest expense in total long and short-term debt) to COD2 (proportion of financial expense in total long- and short-term debt), and the results show that the main conclusions are still robust. First, in

the first column of regression (benchmark regression), the regression coefficient of the asset-liability ratio (assetlr) on the enterprise digital transformation (datatrs) was 6.717, which was significant at the 1% significance level ($p < 0.01$) ($t = 5.895$), indicating that the improvement of the asset-liability ratio significantly promoted the digital transformation of enterprises. This result is consistent with the benchmark regression results. Second, in the second column regression (robustness test), join the new intermediary variables COD2; the asset-liability ratio of the digital transformation regression coefficient is still 4.453 at a 1% significance level ($t = 3.660$). Although the coefficient decreased slightly, it still maintains a significant positive influence, showing that the debt financing pressure still promotes enterprise digital transformation. At the same time, the regression coefficient of COD2 is 26.811, which is significant at the 1% significance level ($p < 0.01$) ($t = 5.268$), indicating that the rising financing cost will further accelerate the digital transformation of enterprises to optimize operating efficiency and reduce long-term financial pressure. Furthermore, the direction of influence and the significance level of the control variables remained largely unchanged. For example, enterprise size (size1) and enterprise age (age) still have a significant positive impact on digital transformation, indicating that large-scale and older enterprises are more capable of promoting digital upgrading; the proportion of tangible assets (Rtangiblea) still has a significant positive impact on digital transformation, indicating that enterprises with higher fixed assets may be more dependent on digital means to optimize management; and the proportion of executive shareholding (shareholding) still has a significant negative impact on digital transformation, indicating that enterprises with higher executive shareholding may be more conservative in digital investment. From the perspective of the explanatory power of the model, the R^2 value increased from 0.099 (benchmark regression) to 0.100 (robustness test), and the overall change was little, indicating that the explanatory power of the model is stable. Furthermore, the F value decreased from 230.920 to 205.890 but remained significant at the 1% significance level, indicating the overall model fit.

The robustness test results further verify the core conclusion of this paper: the improvement of the asset-liability ratio can significantly promote the digital transformation of enterprises, and the financing cost plays an intermediary role in it. That is, a higher asset-liability ratio will push up the financing cost of enterprises, thus further promoting enterprises to improve operational efficiency through digital transformation so as to reduce financial pressure and enhance competitiveness. Different measures of financing cost (COD1 and COD2) have reached similar conclusions, indicating that the research results are more robust.

Table 4. The robustness test

	(1)	(2)
	datatrs	datatrs
assetlr	6.717***	4.453***
	(5.895)	(3.660)
Rtangiblea	24.429***	25.385***
	(4.510)	(4.688)
dual	–0.276	–0.251
	(–0.711)	(–0.647)

(Continued)

Table 4. The robustness test *(Continued)*

	(1)	(2)
	datatrs	datatrs
age	0.539***	0.529***
	(10.810)	(10.608)
size1	2.965***	3.040***
	(9.651)	(9.894)
stateowned	1.066	1.123
	(1.254)	(1.322)
shareholding	–0.107***	–0.096***
	(–6.863)	(–6.156)
COD1		26.811***
		(5.268)
_cons	–89.010***	–91.014***
	(–11.663)	(–11.922)
N	17300	17300
R^2	0.099	0.100
F	230.920	205.890

5 CONCLUSION AND APPLICATION CASES

First, from the theoretical perspective, this paper enriches the research on the factors influencing the digital transformation of enterprises. The existing literature mainly focuses on the impact of technological innovation, market competition, government support, and other factors on the digital transformation, while there are relatively few studies on how the capital structure affects the digital transformation of enterprises. Through empirical analysis, this paper reveals the influence mechanism of the asset-liability ratio on the digital transformation of enterprises and expands the perspective of relevant research. Secondly, from the empirical level, based on the data of listed companies in the Shanghai and Shenzhen A-share manufacturing industry in 2009–2021, this paper adopts robust econometric methods to systematically analyze the impact of the asset-liability ratio on the digital transformation and further discusses the intermediary role of financing cost. The study found that the increase of the asset-liability ratio can promote the digital transformation of manufacturing enterprises, and the cost of financing plays an important transmission role in this process.

With the rapid advancement of the digital economy, manufacturing enterprises are increasingly embracing digital transformation as a key strategy to enhance competitiveness and drive high-quality development. However, the role of capital structure in shaping digital transformation strategies remains an underexplored area. This case study examines how a leading Chinese lithium battery manufacturer leveraged digital technologies to optimize operations, enhance efficiency, and strengthen financial performance under the constraints of a high asset-liability ratio. Established in 2020, the company specializes in the research and production of cylindrical lithium

iron phosphate (LFP) battery cells. Headquartered in Jiangsu Province, its primary production base covers an area of 3,000 acres. The company is committed to becoming a leading technology and production platform for large-format cylindrical LFP battery cells, with a strong R&D team that has nearly 20 years of experience in the power battery industry. Particularly in the "large cylindrical" battery segment, the company possesses strong technological expertise, a robust supply chain, and substantial market demand. To support its innovation-driven approach, it has established five research institutes: the "Battery Cell Research Institute," "Equipment Research Institute," "International Research Institute," "Chassis Structure Research Institute," and "Electronics and Systems Research Institute." Focusing on the LFP technology roadmap, the company targets five core application areas: commercial vehicle electrification, marine electrification, agricultural machinery electrification, microgrid energy storage, and high-end lead-acid battery replacement. The company has independently developed key battery cells, such as the 46800, 38121, and 38910 models, utilizing automotive-grade large cylindrical battery cell technology comparable to Tesla's standards and fully automated production equipment. These battery cells offer four key advantages: safety, fast charging, low-temperature performance, and advanced manufacturing processes. By 2024, the company aims to achieve a total production capacity of 50 GWh, positioning itself as one of the largest cylindrical LFP battery manufacturers. Due to its rapid growth and innovation in lithium battery technology, it was recognized as a global unicorn enterprise in 2024, becoming the first unicorn company in its city.

However, rapid expansion and aggressive investment in research and development have resulted in a high asset-liability ratio, putting financial pressure on the company. Between 2020 and 2024, the company relied heavily on debt financing to scale its production capacity, resulting in a rising asset-liability ratio. To address the challenges posed by increasing financing costs and operational risks, the company actively embraced digital transformation as a means to improve efficiency, reduce costs, and enhance financial stability.

To optimize operations under financial constraints, the company implemented a series of digital transformation initiatives. The first major step was the integration of Industrial Internet of Things (IIoT) technologies across its production lines. By deploying IIoT-enabled sensors and real-time monitoring systems, the company gained greater visibility into machine performance and production efficiency. This allowed for the implementation of predictive maintenance algorithms, reducing unplanned downtime by 30% and lowering maintenance costs by 20%. The ability to anticipate equipment failures and optimize maintenance schedules helped the company improve overall production efficiency without requiring additional capital-intensive investments.

Another critical aspect of the digital transformation was the adoption of AI-driven cost management and financial analytics. Given the company's high debt levels, optimizing cost structures was essential for maintaining profitability. By leveraging artificial intelligence for demand forecasting, the company improved raw material procurement efficiency, reducing inventory costs by 13%. AI-powered financial monitoring systems enabled real-time cost analysis, identifying inefficiencies and minimizing waste. This improved cash flow management and strengthened the company's ability to allocate resources effectively, ensuring that capital was directed toward high-value projects.

In addition to cost optimization, the company also focused on blockchain-based supply chain management to enhance operational resilience and reduce financial risks. A blockchain-powered procurement system was implemented to streamline

supplier coordination, reducing procurement lead times by 23.7%. The improved transparency and traceability minimized defects in critical battery components, lowering warranty costs and enhancing customer trust. The integration of blockchain technology also facilitated more efficient supplier payments, reducing transaction costs and improving supply chain efficiency.

Furthermore, the company adopted digital payment solutions to modernize its financial management. The transition to cloud-based ERP enhanced data integration across departments, improving financial transparency and compliance with regulatory standards. Digital payment systems streamlined transactions with suppliers and partners, reducing reliance on traditional banking channels and enhancing cash flow stability. These initiatives collectively contributed to a more agile and financially resilient enterprise, allowing the company to navigate economic uncertainties more effectively.

Despite high debt levels, the company managed to achieve an average annual revenue growth of 12%, driven by improved production efficiency and cost reductions. Operating costs declined by 18%, enabling the company to enhance profit margins while maintaining competitive pricing in the market. More importantly, its debt repayment capacity improved, strengthening investor confidence and reducing the risk of financial distress. While high leverage often constrains financial flexibility, it can also serve as a catalyst for digital adoption, compelling firms to seek efficiency-enhancing technologies. In this case, the need to manage rising financing costs and maintain competitiveness drove the company to integrate IIoT, AI, blockchain, and cloud computing into its operations. This transformation not only helped mitigate financial risks but also positioned the company for long-term sustainable growth. The case provides valuable insights for other manufacturing enterprises facing similar financial constraints, emphasizing the importance of aligning digital transformation strategies with corporate capital structures. By leveraging digital technologies to optimize cost management, enhance productivity, and strengthen supply chain resilience, companies can turn financial challenges into opportunities for innovation and growth.

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