A study on the economic effects of intelligent development in manufacturing enterprises

Jialin Zhou*

Faculty of Economics and Management, Shenyang Agricultural University, Shenyang, China

Abstract: Due to the advancements in technology and society's development. The development of the global economic system is already significantly influenced by the digital economy. It has had a certain impact on the financial growth of manufacturing businesses. This article selects relevant data from the annual reports of manufacturing enterprises and utilizes a regression model that is benchmarked. Based on an empirical research of sample businesses, the effect of the level of digital transformation on business performance and operational efficiency. Furthermore, the reliability of the regression results has been further demonstrated through robustness tests by replacing the explained variables and expanding the sample size. The results indicate that the digital transformation and upgrading of manufacturing enterprises contributes to improving corporate performance and operational efficiency. This empirical conclusion can offer relevant suggestions for manufacturing enterprises to develop digitally and intelligently.

1 Introduction

In the current wave of rapidly advancing technology. Internet technology is becoming increasingly mature. The convergence of digital technology and network technology has consequently given rise to digital technologies such as big data, cloud computing, artificial intelligence, and blockchain. These technologies are applied in the production and operations of many manufacturing enterprise, contributing to improved efficiency in resource allocation, urging companies to transform and modernize, and improving their core competitiveness. It has provided unprecedented opportunities for the development of manufacturing enterprises. At the mean time, it has intensified competition among enterprises and prompted innovative companies to commercialize their business models to better meet customer needs. It is evident that how to better adapt to market demands and avoid being ostracized from the market is one of the major challenges faced by enterprises today. Therefore, further exploration and research on the digital and intelligent transformation of enterprises is of significant practical importance for promoting the high-quality economic development of enterprises.

The digital transformation of enterprises has become a popular research topic in recent years. Scholars have conducted indepth analysis on the impact of digital transformation on enterprises, providing solid theoretical support for this study. Scholars have analyzed the

* Corresponding author:2022136007@stu.syau.edu.cn

impact of the digital intelligence development of retail enterprises [1], food enterprises [2], and agricultural enterprises [3] on the related economic consequences for these businesses. The digital transformation of manufacturing enterprises has been the subject of relatively little research. Therefore, this article selects relevant corporate data as samples to construct a frequency evaluation system for intelligent development, coupled with empirical analyses using benchmark regression models and fixed effects models to evaluate the impact of intelligent development on the efficiency and performance of manufacturing companies. This article provides theoretical support and decision-making reference for the manufacturing industry's long-term sustainability. The arrangement of the chapters following this text is as follows: This article is divided into five sections. The second section is analyzing theory and hypothesizing research. The third section is the design of research. The fourth section is the empirical analysis. The fifth section is the Conclusion and Outlook.

2 Research Hypotheses and Theoretical Analysis

From the perspective of information asymmetry theory. In a market economy, individuals possess varying degrees of understanding regarding relevant information, and those who have a more comprehensive grasp of information are at a greater competitive advantage, while those who do not are at a disadvantage. Acquiring information from external sources often incurs significant production costs for enterprises. The digital transformation of enterprises through adjustments to their internal structures helps effectively address the issue of resource asymmetry, significantly reducing production costs for the enterprises. At the same time, utilizing the internet can help businesses better acquire the latest market information, enabling them to create and leverage greater value [4]. This paper proposes Hypothesis One based on the analysis above.

H1: The digital and intelligent development of manufacturing enterprises contributes to improving corporate performance.

From the standpoint of operational effectiveness. The digital transformation of businesses has improved management and operational efficiency through intelligent production, self-checkout, and smart customer service, allowing the products and services of the enterprises to better meet customer needs. This helps to save time and labor costs, and enhancing the efficiency of resource allocation can lead to an increase in employee productivity within the organization. At the same time, utilizing digital platforms for collaboration and communication among teams and departments also helps enterprises to break down departmental barriers, achieving information sharing and collaborative work. These improvements help enterprises enhance management efficiency, reduce operating costs, and elevate performance levels [5]. Based on the above analysis, this paper proposes Hypothesis Two.

H2: The digital transformation of manufacturing enterprises helps to enhance operational efficiency.

3 Research Design

3.1 Sample selection and data sources

This article references the statistical methods of frequency for adjectives related to a development that is both digital and intelligent of enterprises as proposed by relevant scholars. This article summarizes the frequency system of adjectives related to the development of intelligence and digitization by collecting and examining the manufacturing companies' 2018–2023 annual reports that are accessible to the public. To ensure the reliability and stability of the article, during the process of data processing and analysis, the proportion of R&D investment (Rdspe) was logarithmically transformed, and the Stata 18.0 software was used to apply a 1% trimming to the continuous variables in the sample data, preventing outliers from affecting the test results. The CSMAR database provides the relevant data. Variable Definition

3.1.1 Dependent variable

Return on Assets (ROA). This article measures the market performance of enterprises using ROA, which is the average total assets to net profit ratio, and applies it in benchmark regression analysis.

Corporate Market Performance (TobinQ). The TobinQ, which measures the market performance of a company by comparing its market value to its total assets, is utilized for benchmark regression analysis.

Inventory Turnover Ratio (ITO). This article measures the operating efficiency of enterprises using the ratio of ITO, which is the operating cost to average inventory, and applies it to benchmark regression analysis.

3.1.2 Explanatory variable

Digital (Dig). Through a review of existing literature, it is evident that scholars have varied approaches to quantifying the relevant indicators of intelligent development in enterprises. Many scholars, such as Fei Wu and others, measure the frequency of relevant keywords related to the digital intelligence development of enterprises in their annual reports as a stand-in measure of how advanced digital intelligence is in businesses [6]. In the corporation's annual report for processing, categorize keywords such as artificial intelligence technology, blockchain technology, cloud computing technology, big data technology, and digital technology applications. Search, match, and summarize the frequency of these keywords to reflect the extent of the company's digital intelligence development. Therefore, in accordance with the research methods used by the scholars mentioned earlier, the paper selects the relevant word frequency of digital technology application in manufacturing enterprises from CSMAR database for statistical analysis and usage.

3.1.3 Control Variables

As we can see in Table 1 that Utilizing existing scholars' research, the following variables are primarily selected. Proportion of R&D Investment (Rdspe), Level, Size, Age, Share[7-8].

Table1 Variable Definition Table

Variable Type	Variable Name	variable symbol	variable declaration
Dependent variable	Return on Assets	ROA	The proportion of the company's net profit to its average total assets
	Corporate Market Performance	Tobinq	The proportion of a company's total assets to its market value
	Inventory Turnover Ratio	ITO	The ratio of business operating costs to average inventory

Explanatory variable	Digital	Dig	Statistical Frequency Analysis of Key Terms in Corporate Annual Reports
Control Variables	Proportion of R&D Investment	Rdspe	Ln（The ratio of research and development investment to operating revenue)
	Level	Level	The proportion of the company's total assets to its total liabilities
	Share	Share	The shareholding ratio of the top ten shareholders of the enterprise
	Size	Size	The logarithm of the total business income of the enterprise
	Age	Age	Total number of years of continuous operation of the enterprise

3.2 Model Configuration

This study aims to investigate how digital transformation affects manufacturing companies' operational efficiency and corporate value, a model is constructed.

$$Y_{it} = \beta_0 + \beta_1 Rdspe_{it} + \beta_2 Share_{it} + \beta_3 Level_{it} + \beta_4 Size_{it} + \beta_5 Age_{it} + \beta_6 Dig_{it} + \varepsilon_{it} \quad (1)$$

In the equation, Y_{it} is the dependent variable. Using ROA, TobinQ, and ITO to Measure, separately. i represents the sample entity of the enterprise, t denotes the sample year， random errors are known as ε, The constant term is β_0, and β_1 to β_6 are the regression coefficients corresponding to the respective variables.

4 Empirical Analysis

4.1 Descriptive statistics

The research sample provides descriptive statistical results. ROA has a maximum of 0.253, a minimum of -0.235, and a standard deviation of 0.0710. It can be observed that The performance levels of manufacturing businesses vary somewhat. From the Digital data, it can be observed that some manufacturing enterprises have begun to prioritize the development of digital intelligence transformation. The data reveals significant discrepancies among the sample enterprises; some have yet to regard digital intelligence transformation as a key focus for advancement. All of the other variables' descriptive statistics fall within the typical range (for further information, see Table 2).

Table2 Descriptive Statistics of Variables

Variable	Observations	Average value	Standard Deviation	Min	Max
Tobinq	9,487	1.947	1.142	0.843	7.654
ROA	9,487	0.0514	0.0710	-0.235	0.253
ITO	9,487	4.219	3.406	0.542	21.15
Dig	9,487	13.97	22.36	1	142
Rdspe	9,487	0.551	0.444	-0.171	2.035
Level	9,487	0.388	0.175	0.0645	0.779
Share	9,487	58.35	14.93	24.15	89.41
Size	9,487	22.27	1.185	20.21	25.97
Age	9,487	20.50	5.473	9	36

4.2 Benchmark regression analysis

The regression analysis employs a fixed effects model for research, and the specific results of the model are illustrated in Table 3. The core explanatory variable's coefficient in the regression findings of column (1), At the 5% level, digital intelligence (Dig) is significant at 0.0001. This initially shows that digital intelligence development has a positive impact on corporate performance. Some control variables also demonstrate a certain level of correlation with the dependent variable at a significant level; for instance, Share is significant at the 5% level, showing a positive impact, which is consistent with traditional logic. Therefore, A significant factor in improving corporate performance is the digital transformation of industrial companies. Assuming a foundation is established.

The coefficient for Dig has been shown to be 0.0044 in the regression results of column (2), which is significant at the 1% level, suggesting that the development of digital intelligence has a positive impact on the operational efficiency of enterprises. Taking into account the control variables, certain control variables (Rdspe, Size) show a significant correlation with ITO, indicating that their impact on ITO is significant at the 1% and 5% levels. Therefore, improving operational efficiency is greatly aided by manufacturing companies' digital transformation. Assuming the second condition is established.

Table3 Results of the benchmark regression analysis

	(1)	(2)	(3)
VARIABLES	ROA	ITO	Tobinq
Dig	0.0001**	0.0044***	0.0010***
	(2.0857)	(2.8141)	(2.6295)
Rdspe	0.0002	0.2487***	2.6762***
	(0.1068)	(2.9104)	(197.7263)
Level	0.0008	0.1826	-0.1553***
	(0.1720)	(0.7830)	(-3.3953)
Share	0.0001**	-0.0070***	0.0021***
	(2.2457)	(-2.8589)	(3.1634)
Size	0.0039***	0.0744**	0.1084***
	(5.3370)	(2.1289)	(7.6451)
Age	0.0001	-0.0014	0.0156
	(0.4607)	(-0.2094)	(1.0776)
2019.Year	-0.0017	-0.0951	-0.0960***
	(-0.5996)	(-0.6947)	(-5.3557)
2020.Year	-0.0020	-0.0027	-0.1122***
	(-0.7045)	(-0.0199)	(-3.6502)
2021.Year	-0.0056**	-0.1486	-0.1853***
	(-2.0224)	(-1.1160)	(-4.1588)
2022.Year	-0.0056**	-0.1311	-0.1524***

	(-2.0779)	(-1.0212)	(-2.6112)
2023.Year	-0.0073***	-0.2123*	-0.2012***
	(-2.7339)	(-1.6578)	(-2.7798)
Firm	Control		
Constant	-0.0404***	2.8372***	-2.2046***
	(-2.5887)	(3.7887)	(-5.4058)
Observations	9,487	9,487	9,487
R-squared	0.006	0.004	0.866

t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

4.3 Robustness Test

To further investigate the credibility of the research findings. To investigate the credibility of the research findings in more detail. This article employs the substitution variable method to replace the dependent variable ROA with Tobin's Q for a robustness check of Hypothesis One. Conducting a thorough assessment to evaluate the link between Manufacturing companies' digital transformation and corporate performance, the relevant data were standardized and subjected to a regression examination. The columns (3) of Table 3 display the results.

Although there are some fluctuations in the regression coefficients in the results, certain control variables still demonstrate a significant link exists between corporate performance and correlation. At the mean time, the explained variable (TobinQ) is significantly related to the digital development of enterprises at the 1% level. The validity of Hypothesis One is further supported by this validation, which shows how strong the empirical findings are.

At the same time, a robustness test for Hypothesis II was conducted using an expanded sample size based on the model. This article expands the sample size to the period from 2015 to 2023 and conducts a verification by analyzing the publicly available annual report data of relevant manufacturing enterprises, with results presented in Table 4. The regression coefficients show some variability, as evidenced by the results, they remain highly consistent with the outcomes presented in Table 3 and maintain a high level of significance, demonstrating the validity of the empirical findings. This verification further confirms the validity of Hypothesis Two.

The outcomes of the regression analysis indicates that the digital transformation of manufacturing enterprises facilitates their ability to respond more effectively to market changes and risk challenges, reduces operational risks, aids in cost reduction and efficiency enhancement, and make certain that enterprises develop in a sustainable and healthy manner. This aligns with the conclusions of relevant scholars' research [9]. The construction of digital intelligence can also assist enterprises in achieving a deep integration of business and information systems, contributing to the enhancement of the efficiency of capital utilization. This can significantly save time and labor costs for enterprises, thereby improving operational efficiency, further corroborating the research conducted by relevant scholars [9-10].

At the same time, the impact of the digital transformation of enterprises on corporate performance also involves a certain transmission mechanism, which has not been explored in this paper, and further research will be conducted on this in the future. The digital transformation of enterprises has a multifaceted impact, not only affecting the financial aspects of companies but also significantly positively influencing their market value. This study further substantiates this point and reinforces existing research.

Table4 Expansion of the sample size regression analysis results.

	(1)
VARIABLES	ITO

DIG	0.0078***
	(5.2833)
Rdspe	-1.6934***
	(-42.4006)
Level	1.0296***
	(5.2939)
Share	0.0004
	(0.2105)
Size	0.0107
	(0.3369)
Age	-0.0152***
	(-2.5888)
Year	Control
Firm	Control
Constant	5.8924***
	(8.4415)
Observations	11,150
R-squared	0.158

t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5 Conclusion and Outlook

5.1 The conclusion of research

Based on innovation theory, this paper empirically analyzes the connection between the growth of digital transformation and the operational effectiveness and corporate performance of listed manufacturing companies between 2018 and 2023. The research in this article reveals a positive correlation between the advancement of manufacturing enterprises through the use of digital and intelligent technology., their performance, and operational efficiency, indicating that digital transformation contributes to enhancing corporate performance and operational efficiency, thereby increasing corporate value. However, some control variables exhibit a negative correlation with the explained variables, which may be due to differences between the enterprise samples in certain aspects as well as the influence of certain random factors. Overall, the digital transformation of enterprises plays a significant role in enhancing corporate performance and operational efficiency.

5.2 Countermeasure recommendations

Empirical research indicates that the degree of digital intelligence development in enterprises has a positive impact on their market performance. With the continuous development of technology and the guidance and drive of national policies, the intelligent transformation of manufacturing enterprises is an inevitable trend for future development. The exploration and innovation of digital intelligence by enterprises contribute to the expansion of their market scale, reduce the asymmetry of market information, and lower the communication costs of information between different levels within the organization, thereby enhancing operational efficiency and ultimately improving the profitability and developmental capacity of the enterprise.

However, there are hazards associated with the growth of digital intelligence in businesses. It is necessary to control the proportion of R&D investment in digital intelligence development to prevent excessive R&D expenditure from placing undue pressure on other business segments, increasing debt repayment burdens, and adversely affecting the normal operations of the enterprise. Manufacturing enterprises need to focus more on how the size of operations and the expenses of digital transformation are related to flexibility. They should promptly obtain market information, incorporate customer suggestions, improve service quality, and enhance product innovation. Furthermore, they should develop upgrade plans that align with the scale, financial resources, and operational status of the enterprise.

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