

Enterprise Digital Transformation, Dynamic Capabilities and Innovation Performance

Lulu Chen^{1,*}

¹College of Economics and Management, Southwest University of Science and Technology, Mianyang 621010, China

* Corresponding author

Abstract: Accelerating enterprise digital transformation is a necessary way to achieve high-quality economic development under the new development pattern, and it also provides an opportunity for enterprise development to "change the lane to overtake", so it is necessary to discuss the effect and mechanism of enterprise digital transformation to improve innovation performance. Based on the theory of technological innovation and the theory of dynamic capability, we use text analysis to construct the index of enterprise digital transformation from 2008 to 2022, empirically examine how enterprise digital transformation affects innovation performance, explore the mediating effect of dynamic capability, and summarize the "enterprise digital transformation--dynamic capability--innovation performance". The mediating effect of dynamic capabilities is explored, and the path of "enterprise digital transformation - dynamic capabilities - innovation performance" is summarized. We empirically test the impact of enterprise digital transformation on innovation performance and its mechanism. The empirical results show that digital transformation significantly affects the dynamic capability decision-making behavior of enterprises, and the innovation performance of enterprises is significantly improved as a result. The findings provide micro evidence for the study of the intrinsic mechanism of enterprise digital transformation to promote innovation performance, and provide clear insights for enterprises to promote digital transformation, develop dynamic capabilities, and improve innovation performance.

Keywords: Digital transformation, Dynamic capabilities, Innovation performance, Textual analysis.

1. Introduction

At present, the rapid development of emerging technologies, with the Internet, big data, cloud computing, AI and other digital technologies continue to promote traditional enterprises to networked, intelligent, digital, the world is accelerating into a new era of digitization. 2020, China's digital economy, the core industry added value of the gross domestic product (GDP) accounted for the proportion of 7.8% of the digital economy for the sustained and healthy development of the community to provide a strong impetus. 2021 is the first year of the "14th Five-Year Plan", which is the first year of the digital transformation, and the central and local governments have intensively introduced a large number of policies related to digital transformation. It can be foreseen that the future economic activities of the society, the life scene, the governmental governance, and the transformation of the enterprises will inevitably be included in the wave of the digital transformation, and it is inevitable to accelerate the digital transformation of enterprises. It is imperative to accelerate the digital transformation of enterprises. Leading enterprises in many fields have completed digital transformation with the help of digital technology, developed new business models, and opened the gap with lagging traditional enterprises, and the global epidemic has further promoted the digital transformation of enterprises. However, according to Accenture's digital transformation index for Chinese enterprises, only 7% of Chinese enterprises have significant digital transformation effects, many manufacturing enterprises lack a foundation for digital transformation, and there is a large difference in digitalization capabilities between enterprises. Therefore, to fully understand and grasp digital transformation, it is still indispensable to logically and systematically sort out and summarize the existing literature. Based on this, this paper

builds an overview framework around the theme of digital transformation, clarifies the concept of digital transformation, and elaborates the issue of enterprise digital transformation in terms of readiness, strategy, and contribution, aiming to help scholars understand the issue of digital transformation in a more systematic and comprehensive way by combing and summarizing the relevant research literature and clarifying the direction of future research accordingly.

The enterprise digital transformation contribution degree, i.e., the digital transformation benefits are mainly expressed as follows:(1) Digital transformation brings organizational performance and new customer experience to enterprises. Enterprises in the transformation process, the use of digital technology to accelerate the intelligence of new products and services, effectively through the dynamic ability to positively affect the innovation ability and performance of enterprises [1], with the promotion of the digital economy policy and the deepening of the digital transformation of enterprises, the effect of enterprise performance enhancement highlights [2], enterprises through the digital change to enhance the awareness of service, from the digital service to profit from, thus promoting the enhancement of enterprise performance [3]. Industrial digital transformation has an important impact on the improvement of enterprise innovation ability and industry efficiency, although the improvement of industry efficiency and other aspects can not directly affect consumer upgrading, but it has a concise impact on it. Digitalization endows enterprises with greater competitiveness, and can also create greater social and economic benefits when meeting user needs; (2) efficiency improvement. The digital realm is a strategic tool that not only generates innovation but also transfers knowledge and technology [4]. Driven by digital transformation, the enterprise's digital service capabilities enable various links around the consumer to improve overall efficiency, which is conducive to the enhancement of the

enterprise's dynamic capabilities [5], and the capital output elasticity of the enterprise in the process of digital transformation is much higher than the labor output elasticity, and the digital efficiency will change over time; (3) business model innovation. Digital transformation brings business model changes to enterprises, and digitalization drives the reinvention of the five business models [6], on the basis of which digitalization provides a wide range of possibilities for enterprise-customer interactions, which gives rise to business model innovation. Digital technology as a new channel of information or interaction with customers and other stakeholders, affecting business processes, bringing unlimited opportunities for business model innovation, in order to greater productivity, more competitive, thus enhancing the business model innovation can be, accelerating the process of business model innovation. Therefore, the impact of digitalization is "a disruptive and destructive influence", and the practice of enterprise digital transformation is an all-encompassing change that affects all aspects of organizational performance, industry performance, consumer experience, business models and society.

Enterprise digital transformation is the process of reconstructing the internal management mode and innovation mode of an enterprise using a combination of artificial intelligence, cloud computing, blockchain, big data, Internet+ and other emerging technologies. Enterprise digital transformation will subvert the traditional management mode and innovation mode of enterprises, provide a new impetus for enterprise innovation, and guide the enterprise innovation performance to achieve a leap forward. In this context, it is of great significance to study the relationship between enterprise digital transformation and innovation performance. Whether enterprises can seize the opportunity of digital transformation and give full play to the driving effect of digital technology on enterprise innovation performance has become a hot topic of common concern for theoretical exploration and practical research. The theoretical foundation and empirical experience on the phenomenon of enterprise digital transformation-driven innovation are relatively rich, but there are still shortcomings. First, most studies agree that in the era of digital economy, digital transformation is the key to build core competitiveness of enterprises, but the common research method is theory and case study, and there is little literature exploring the relationship between digital transformation and enterprise innovation performance through empirical research. Second, although a few literatures have explored the impact of enterprise digital transformation on innovation based on the empirical perspective, they lack the exploration of intermediate mechanisms. Currently, the latest digital transformation research perspective is based on dynamic capabilities, i.e., enterprises carry out innovation activities on the premise of a certain degree of capabilities and resources. Analyzing enterprise digital transformation based on dynamic capabilities, for one thing, enterprise digital transformation is regarded as the catalyst of dynamic capabilities; for another, the key guarantee for enterprises to obtain core competitiveness is dynamic capabilities, and innovation performance is an important performance of core competitiveness [7]. Therefore, from the perspective of dynamic capabilities, this paper takes A-share listed companies from 2008 to 2022 as the research object, measures the degree of enterprise digital transformation based on textual analysis, identifies the impact and intermediate mechanism of digital transformation on innovation

performance, and provides new empirical conclusions for the relationship between enterprise digital transformation and innovation performance.

2. Theoretical Analysis and Research Hypothesis

2.1. Dynamic capability

The core of the dynamic capabilities theory is how to seek and maintain competitive advantage in the unpredictable external environment. Teece and Pisano et al. (1997) [8] put forward the three-dimensional framework of "position, process and path", and the process-based represents the dynamic capabilities. As research continues to expand, Eisenhardt and Martin (2000) [9] note the importance of learning, which to a certain extent is external to the dynamic capability system, but can drive and stimulate the continuous evolution of dynamic capabilities. Recent studies have shown that the essence of digital transformation is learning, in which enterprises trigger and drive the continuous evolution of dynamic capabilities by reintegrating internal and external resource elements, optimizing product processes and industrial structures, and so on. Complexity and uncertainty make digital transformation very risky, and dynamic capabilities are the essential guarantee for enterprises to quickly adapt to uncertain environments such as technology and markets. The evolution of dynamic capabilities enables enterprises to maintain their core competitive advantages, and one of the most important manifestations of their core competitive advantages is their innovation performance. Dynamic capabilities are the source of driving force for enterprises to carry out innovation activities and allocate resources efficiently.

2.2. Digital Transformation and Enterprise Innovation Performance

Enterprise digital transformation for innovation performance improvement is manifested in the following aspects: first, enterprise digital transformation increases innovation opportunities. The traditional information management system can only analyze and store the internal data of the enterprise, and can seldom respond to the rapidly changing external environment. When enterprises introduce digital transformation tools such as cloud computing and artificial intelligence, they can conduct data tracking and analysis and demand forecasting according to actual needs, so that they can efficiently identify innovation opportunities on the basis of analyzed data. Second, enterprise digital transformation improves innovation efficiency. With the rapid development of emerging digital technologies, the process of enterprise innovation activities has become more and more accurate and efficient, which not only greatly reduces repetitive work, but also promotes the transition of enterprises from innovative to accurate, and motivates talents to carry out innovative activities. Finally, enterprise digital transformation reduces the cost of innovation. Enterprises need to invest a lot of money in the initial stage of innovation, and the innovation process has a series of uncertainties such as long cycle and high risk. When the enterprise will be emerging digital technology applied to enterprise R & D innovation, it can significantly reduce the cost of innovation. Through the application of a large number of digital technologies, innovation costs are reduced while innovation efficiency is improved, which will motivate enterprises to invest more

resources in technological innovation and product development activities, thus forming a positive impact. Based on this, this paper proposes hypothesis 1:

H1: Digital transformation for firms' innovation performance.

2.3. Digital Transformation, Dynamic Capabilities and Innovation Performance Improvement

Innovative activities resulting from digital transformation are based on certain elements and resources. Studies have shown that dynamic capabilities are essential to the digital transformation process and provide the basis for innovative activities in enterprises. The digital transformation of enterprises relies on the enhancement of innovation capabilities, which in turn promotes the improvement of innovation performance. Emerging digital technologies, with their intelligent information capture and other functions, dynamically adjust the enterprise's innovation goals. Digital transformation is an innovation of the management mode, and the key is to stimulate enterprises to carry out a series of knowledge and technology exploration, and then truly enhance the innovation ability. Enterprise digital transformation promotes innovation performance by enhancing absorptive capacity. In the context of the digital twin, the boundaries between the enterprise and the external environment are becoming increasingly blurred. And digitalization can share and link information, which not only broadens the enterprise knowledge source and information channels, but also realizes the interactive learning of the internal and external environment. Digital transformation not only enhances the enterprise's ability to absorb information and resources efficiently, but also evolves the basic supporting operational capabilities into complex and excellent dynamic capabilities, which in turn drives the enterprise's innovation performance. The enterprise digital transformation process promotes innovation performance by facilitating adaptive capabilities. Enterprise digital transformation is an all-round and multi-dimensional reshaping and upgrading process, in which the application of digital technology not only involves the operation of traditional processes, business models and the construction of the innovation system, but also the use of intelligent tools to design, produce and even sell products, which further enhances the enterprise's product and technology innovation ability and environmental adaptability. Based on this, this paper proposes hypothesis 2:

H2: The enhancement of firms' dynamic capabilities in the context of digital transformation helps to improve innovation performance.

3. Research Design

3.1. Sample selection and data sources

In order to study the impact of enterprise digital transformation on innovation performance and its mechanism of action, this paper selects China's A-share listed companies from 2008 to 2022 as the initial sample, and the data are from Cathay Pacific. The data of enterprise digital transformation, dynamic capability, and innovation performance are obtained by manual collation. The samples are processed according to the following criteria: (1) sample data with missing information in the panel data are excluded; (2) observations whose stocks of listed companies are in abnormal trading

status, such as ST and *ST, are excluded. A total of 25,111 observations are obtained.

3.2. Variable definitions

Explained variable: innovation performance [10]. Because the number of patent applications can reflect the real innovation performance of enterprises, enterprises with good innovation performance will continue to produce new technologies, and the number of patent applications will also rise. The number of patent applications is more reflective of the actual level of innovation performance than the number of patents granted. Patent grants require testing and payment of annual fees, and there is great uncertainty and instability, while the number of patent applications is more stable and reliable than the number of patents granted, and it is very likely that the patented technology has already had a significant impact on the innovation performance in the process of applying for patents. Therefore, patent application data are more suitable for measuring innovation performance ($\ln Apply$).

Explanatory variable: enterprise digital transformation. The digitization-related word frequency of enterprise annual reports is adopted as a proxy variable for enterprise digital transformation (Dig). There are two main ways to measure enterprise digitization in existing studies, one is to use text analysis to do related word frequency statistics; the other is to calculate the amount of investment in enterprise digitization-related hardware and software. Using Pycharm software programming to count the digitization-related word frequencies in the key chapters of the annual reports of the sample enterprises, and drawing on the research of Wu Fei et al. [11], the keywords of digital transformation were identified from several levels of the enterprise's artificial intelligence technology, big data technology, cloud computing technology, and blockchain technology. Then, the total number of digitized word frequencies of enterprises in each year after cleaning is counted, and the natural logarithm is taken as a proxy variable for enterprise digital transformation after adding 1 to it.

Mediating variable: dynamic capability (DC) (12). Since dynamic capability is closely related to the total R&D expenditures of an enterprise, this paper measures dynamic capability as the ratio of R&D expenditures to total assets.

Control variables. Referring to previous studies and considering the key factors affecting the innovation performance of enterprises, the following control variables are selected: company size ($Size$), gross profit margin of sales ($GrossProfit$), net profit margin of total assets (ROA), proportion of intangible assets ($Intangible$)

3.3. Measurement model

According to the theoretical analysis, this paper believes that enterprise digital transformation affects enterprise innovation performance by influencing dynamic capabilities, and in order to identify whether this influence and the mechanism of action exist, the following empirical model is constructed:

In order to test the role of enterprise digital transformation on innovation performance, this paper constructs model (1) as a benchmark regression model

$$\ln Apply = C + \alpha_0 Dig + \alpha_1 Size + \alpha_2 GrossProfit + \alpha_3 ROA + \alpha_4 Intangible + \varepsilon_i \quad (6.1)$$

4. Empirical Results and Analysis

4.1. Descriptive statistics

The descriptive statistics of the main variables are presented in Table 1. As can be seen from Table 1, the maximum value of lnApply is 0.41, the minimum value is 0, and there are obvious differences in the innovation performance of each listed company. the mean value of Dig is larger than the median, indicating that the degree of digital

transformation of some sample enterprises is higher, and indirectly indicating that the degree of digital transformation of the enterprise is obvious differences among enterprises, some enterprises have long been digitalized by virtue of their own industry advantages, while individual The mean value of DC is 0.02, which indicates that the sample enterprises have relatively insufficient dynamic capabilities and lack the ability to search for innovation opportunities. The descriptive statistics of the variables are basically consistent with the results of existing studies.

Table 1. Descriptive statistics for key variables

VarName	Obs	Mean	SD	Min	Median	Max
Dig	25111	1.78	1.53	0	1.61	6.47
DC	20869	0.02	0.03	0	0.02	0.41
lnApply	25097	57	216	0	13	6896
Size	25111	22.14	1.35	19.32	21.90	26.45
GrossProfit	25108	0.30	0.18	-0.06	0.27	0.87
ROA	23075	0.04	0.07	-0.37	0.04	0.26
Intangible	25043	0.04	0.05	0.00	0.03	0.38

4.2. Correlation analysis

Table 2 demonstrates the correlation coefficients between the variables. The correlation coefficient between Dig and lnApply is 0.088 and is significant at 1% level, indicating that digital transformation is positively associated with innovation performance, which is in line with expectations. The

correlation coefficients between digital transformation and dynamic capabilities are all significantly positive, which is consistent with the previous hypothesis. The correlation coefficients between the variables are basically less than 0.5, indicating that the possibility of covariance between the variables is very small.

Table 2. Correlation analysis of key variables

	lnApply	Dig	Dc	Size	GrossProfit	ROA	Intangible
lnApply	1						
Dig	0.088***	1					
Dc	0.037***	0.328***	1				
Size	0.333***	0.028***	-0.219***	1			
GrossProfit	-0.090***	0.162***	0.316***	-0.195***	1		
ROA	0.00400	-0.023***	0.063***	0.017**	0.372***	1	
Intangible	0.0100	-0.076***	-0.111***	0.087***	0.014**	-0.044***	1

4.3. Regression results and analysis

In order to test the impact of enterprise digital transformation on innovation performance, regression analysis is conducted according to the model constructed in the previous section, and the results are shown in Table 3. Column (1) of Table 3 demonstrates the impact of enterprise digital transformation on innovation performance without considering other factors, and the results show that the regression coefficient of Dig is 21.978 and positive at 1% significance level, which indicates that the higher the degree of enterprise digital transformation, the better the enterprise's innovation performance is; on the basis of column (1), this paper adds Size, GrossProfit, ROA, Intangible as control variables into the regression model, the results are shown in column (2) of Table 3, at this time the regression coefficient

of Dig is 11.554, which is still positive at the 1% significance level, and consistent with the results of column (1); on the basis of column (2), the fixed effects of the year of the column are further controlled, and the results are shown in column (3) of Table 3, at this time the regression coefficient of Dig's regression coefficient is 7.707, which is still positive at the 1% significance level and consistent with the results in the first two columns. It indicates that enterprise digital transformation significantly promotes innovation performance. In the era of digital economy, enterprise digital transformation has become a mainstream trend, and enterprises rely on digital technology to collect massive data, capture external innovation opportunities, enrich R&D technology, optimize innovation processes, and save innovation costs, so as to achieve effective enhancement of innovation performance. Therefore, H1 is validated.

Table 3. Panel data regression results

variable	(1) lnApply	(2) lnApply	(3) lnApply
dig	21.978*** (0.848)	11.554*** (0.953)	7.707*** (1.165)
Size		43.266*** (1.387)	40.212*** (1.485)
GrossProfit		-37.434*** (10.020)	-47.556*** (10.036)
ROA		26.645 (18.928)	35.071* (19.015)
Intangible		52.798* (29.683)	47.507 (29.620)
_cons	5.584* (2.992)	-914.763*** (30.413)	-850.517*** (32.158)
year	NO	NO	YES
N	25097	23003	23003

4.4. Mechanism analysis

In order to further test whether the digital transformation of enterprises has an impact on innovation performance by affecting dynamic capabilities, this paper designs the following mediation effect test model with reference to the mediation effect step-by-step test proposed by Wen Zhonglin and Ye Baojuan (2004):

$$\ln\text{Apply} = \alpha_1 + \beta_1 \text{Dig}_{it} + \gamma_1 X + \rho_t + \varepsilon_{it} \quad (7.1)$$

$$\text{DC} = \alpha_2 + \beta_2 \text{Dig}_{it} + \gamma_2 X + \rho_t + \varepsilon_{it} \quad (7.2)$$

$$\ln\text{Apply} = \alpha_3 + \beta_3 \text{Dig}_{it} + \delta M + \gamma_3 X + \rho_t + \varepsilon_{it} \quad (7.3)$$

Table 4 reports the regression results based on equations (7.1) through (7.3). In this paper, the number of invention patents is used as a proxy variable for dynamic capabilities

(DC), and column (1) of Table 4 shows the baseline estimation results, where the Dig coefficient reflects the total effect of firms' digital transformation on the improvement of their innovation performance, and the mediator variable, dynamic capabilities, is introduced based on model (1) to test the existence of the mediating effect of DC. The empirical results in column (2) show that enterprise digital transformation positively affects its DC, which means that enterprise digitization can motivate enterprises to carry out a new management mode. The regression results in column (3) show that the regression coefficient of Dig is 5.934 and the regression coefficient of DC is 829.907, and both are significant at the 1% level, which indicates that the mediating effect of DC exists, and H2 is tested. The digital transformation of enterprises brings radical changes for enterprises, the change of enterprise innovation mode will cause enterprise pain, whether enterprises can quickly adapt to the change of innovation mode, the dynamic ability to play a key role, the digital transformation through the enhancement of the dynamic ability to enhance the innovation performance.

Table 4. Intermediary test results

	(1) lnApply	(2) DC	(3) lnApply
Dig	7.707*** (1.165)	0.002*** (0.000)	5.934*** (1.360)
DC			829.907*** (80.080)
Size	40.212*** (1.485)	-0.004*** (0.000)	51.214*** (1.754)
GrossProfit	-47.556*** (10.036)	0.023*** (0.001)	-73.721*** (12.537)
ROA	35.071* (19.015)	-0.015*** (0.002)	53.437** (22.063)
Intangible	47.507 (29.620)	0.004 (0.003)	27.351 (37.956)
_cons	-850.517*** (32.158)	0.094*** (0.004)	-1120.418*** (39.261)
year			YES
N	23003	18915	18909

5. Research Conclusions and Insights

5.1. Research conclusion

In the era of digital economy, enterprise digital transformation has become a mainstream driver of innovation performance. This paper adopts text analysis to construct the index of enterprise digital transformation from 2008 to 2022, empirically examines how enterprise digital transformation affects innovation performance, explores the mediating effect of dynamic capabilities, and summarizes the path of "enterprise digital transformation--dynamic capabilities--innovation performance". The mediating effect of dynamic capabilities is explored, and the path of "enterprise digital transformation - dynamic capabilities - innovation performance" is summarized. The path of "enterprise digital transformation - dynamic capability - innovation performance" is summarized. Enterprise digital transformation has a significant contribution to innovation performance, enterprise digital transformation positively affects dynamic capability, and plays a significant mediating role between enterprise digital transformation and innovation performance. This finding not only provides arguments for the positive impact of digital transformation on innovation performance, but also solves the problem of bias in the cross-sectional questionnaire data and provides a more effective causal identification.

5.2. Research implications

Starting from the dynamic ability, dynamic ability has the function of driving data analysis platform, data operation platform, data empowerment platform, in the future, we can build the enterprise digital transformation paradigm based on the dynamic ability, break the digital resource barriers, promote the empowerment of digital platforms, deepen the effect of the digital drive, not only confined to the impact of digitalization on a single management function and operation process mechanism, coupling the dynamic ability to the various links in the enterprise and business activities. On this basis, we can also explore how dynamic capabilities affect the digital transformation of enterprises, and provide all-round, multi-level protection for the digital transformation of organizations.

From the enterprise level, it is important to respond to the wave of the digital economy and grasp the opportunities and challenges brought by enterprise digital transformation. In the process of digital transformation, enterprises should formulate the best transformation strategy according to their

own actual situation, and should not blindly pursue advanced technologies and novel innovation modes. Enterprises should pay more attention to dynamic capabilities and focus on improving their own innovative, absorptive and adaptive capabilities, so as to better serve their innovation processes and modes, and ultimately improve their innovation performance.

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