Digital Transformation and Firm Innovation Quality: Empirical Evidence Based on Listed Companies in China, 2011-2021

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Abstract. The development of science, technology, and social progress has made digital development a new driving force for social development. National policies have driven the development of the digital economy and enterprise digital transformation. This paper examines the impact of enterprise digital transformation on the quality of innovation b using an Ordinary Least Squares (OLS) model and fixed effect model. The sample used includes A-share listed companies in Shanghai and Shenzhen from 2011 to 2021. The findings indicate that enterprise digital transformation can improve the quality of innovation in enterprises, and the results pass a series of robustness tests. This research analyzes the effect of digital transformation on the quality of innovation and its mechanisms at the level of listed companies. The analysis enriches the theory of enterprise digital transformation in innovation quality and provides research support for the high-quality development of enterprises.

Keywords: quality of corporate innovation, digital transformation, quality development, fixed effects.

1. Introduction

High-quality development is identified as the highest priority in all specific deployments by the report of the Twentieth Party Congress. The report highlights that this type of development is the primary task required to build a modernized socialist country in a comprehensive way and is an essential requirement for Chinese-style modernisation. The quality of enterprise innovation is a vital indicator used to assess the high-quality development of businesses. The quality of enterprise innovation refers to a comprehensive assessment of a company's innovation capability. The Outline of the Fourteenth Five-Year Plan for National Economic and Social Development and the Vision 2035 also states that innovation-driven development must be followed, with a focus on enhancing the technological innovation capacity of businesses, as well as strengthening the competitive advantages of the manufacturing industry, to promote high-quality manufacturing industry development. Currently, China is one of the world's leading manufacturing countries. However, its innovation efficiency remains low, and the quality and effectiveness of innovation are far inferior to those of major developed nations. Meanwhile, China's manufacturing industry is under significant pressure of being squeezed at both ends of the global value chain. Recently, scholars have primarily analysed the influencing factors affecting corporate innovation quality, considering aspects such as goodwill impairment, the digital economy, and legal protection. Scholarly literature indicates the significant negative effect that goodwill impairment has on corporate innovation quality (Tan Jin et al., 2023)[1]. Also, it has been suggested that legal protection has a considerable positive effect on corporate substantive innovation along with the general quality of innovation. On the contrary, it may have a dampening effect on strategic innovation (Zhou Zhou et al., 2023)[2]. Government subsidies and tax incentives have a positive incentive effect on the quality of digital firms' innovation (Jingwen Zhang and Jinyao Tong, 2023)[3] , while trade in digital service imports has a significant promoting effect on the quality of innovation of Chinese firms (Fang Hui et al., 2022)[4] , and there is also literature to show that the digital economy can significantly enhance the quality of firm innovation (Song Jing et al., 2023)[5] .Moreover, certain scholars have examined the impacts related to the enhancement of enterprise innovation quality, which can increase corporations' competitiveness and foster their sustainable and healthy growth. Thus, it becomes imperative to investigate ways of boosting

enterprise innovation quality with empirical evidence and objective data, which can yield theoretical and practical insights.

Since 2017, the government work report has included the digital economy yearly. Digital transformation has further progressed due to policy dividends. In 2022, the scale of China's digital economy reached 50.2 trillion yuan, and had a nominal year-on-year growth of 10.3%, significantly higher than the nominal growth rate of GDP for 11 consecutive years in the same period. The proportion of China's digital economy in GDP is equal to the proportion of the secondary industry in the economy, equalling 41.5%. According to the "China Digital Economy Development Research Report (2023)". The 20th CPC National Congress recommended accelerating the development of the digital economy, promoting deep integration between the digital economy and the real economy, and creating digital industry clusters with international competitiveness. This indicates that the digital economy has become a focal point for the CPC Central Committee, and that the growth and success of the digital economy has provided new areas and energy for economic and social development. The thriving digital culture is driving China to create a novel development scenario and establish new competitive strengths as a great power. The innovative, pervasive, and comprehensive nature of the digital economy has established it as a new impetus for economic growth and an essential tool for modernising China's traditional industries. Currently, China's enterprises are undergoing a dynamic digital transformation, regularly presenting new impetus and benefits for development, and adding significant force to the creation of modernised economic systems and novel development models.

Currently, research is still exploratory in terms of effectively combining digital transformation and firm innovation quality, with only a few works examining the relationship between the two. For instance, Qiu Yangdong (2022)[6] and other studies have affirmed that digital transformation can notably enhance enterprise innovation performance, playing a partial mediating role in the process of digital change affecting such innovation. This indicates that the development of the digital economy can offer favourable external factors for enterprise innovation. According to studies by Liu Chang et al. (2023)[7], Zhang Shuhan and Li Xiaoxiang (2023)[8], Jingru Wang and Yao Yi (2023)[9], He Zhengchu et al. (2023)[10], and Guo Feng et al. (2023)[11], digital transformation can considerably enhance the green innovation efficiency of manufacturing firms, the level of enterprise integration innovation, enterprise research and development innovation, manufacturing enterprise innovation efficiency, as well as the quantity and quality of such firms' green technology innovation. The current literature suggests that the development of the digital economy can increase the total factor productivity of firms by addressing financing constraints, enhancing innovation levels, and promoting the digital transformation mechanism. This has been shown by Guo Feng et al. (2022)[12], and other studies. Additionally, the digital transformation of firms can notably improve their environmental, social, and governance (ESG) performance, as demonstrated by Hu Jie et al. (2023)[13].

Digitalisation is gradually permeating various industries with the development of digital and information technology. Digital innovation in China has a significant impact on enterprise innovation quality, not just in the digital industry. It is crucial to investigate whether digital transformation within enterprises can affect their innovation quality. Therefore, this paper empirically investigates the impact of digital transformation on the quality of corporate innovation, using listed companies in China as the research subject, spanning from 2011 to 2021. In comparison to the established literature, this paper may contribute in the following ways: firstly, it examines the impact of firms' digital transformation on innovation quality from the perspective of digital economic development, which broadens and deepens the existing academic literature in the area of digital development. Secondly, this paper examines the impact of enterprise digital transformation on innovation quality by exploring its mechanism from a theoretical perspective. The OLS model and fixed effect model are applied to quantitatively and empirically test this impact, providing a novel approach for the quantitative analysis of research related to high-quality development. Thirdly, this paper addresses the issue of robustness more effectively by changing the method for measuring enterprise innovation quality and digital transformation. The methods of double clustering robust standard errors and interaction fixed effects are applied to enhance the benchmark regression model.

2. Theoretical mechanisms and research hypotheses

The digital transformation of companies allows for the collection, optimisation and allocation of technological innovation resources, enhancing their independent innovation capability. On one hand, with the use of digital technology, companies can stay up-to-date with industry dynamics and technological innovation, thus reducing the likelihood of innovation failure. Digital transformation offers novel tools and a platform for research and development, promoting the transition of the innovation mechanism, and empowering an acceleration in innovation output. Conversely, digital technology enables innovators to overcome temporal and spatial limitations, facilitates the speedy spread of knowledge and information, and lowers the cost of trials, errors, and of searching for information. Moreover, companies can leverage big data to study innovation behaviour and identify innovation paths, thereby streamlining the innovation process and accelerating research and development of innovative technologies, ultimately elevating the quality of their innovation. Furthermore, this paper posits that the digital transformation of companies can enhance the quality of their innovation by addressing three aspects, namely media supervision, financing constraints, and technological innovation capacity. The specific roles of this process are described in the following:

Firstly, enterprise-level digital transformation enhances the quality of innovation within an organisation, through observing the media. Amidst the deep progress of the digital economy, digital transformation has gathered mass attention and coverage from the media. The media's focus on the nexus between digital transformation and excellence in enterprise innovation can be observed in the following facets. To begin with, the media serves as a crucial carrier of information, and its pieces of reportage concerning businesses are likely to steer public opinion towards the direction a company takes. Companies often attract media attention and coverage following successful digital transformations to publicize the benefits and outcomes of their strategies, which, in turn, helps build a positive image in the public's perception and improves brand awareness. Moreover, the primary target audience of media reports comprises stakeholders of the company. Providing effective information to stakeholders within the company reduces information asymmetry, minimizes information search and market transaction costs, mitigates potential resource discrepancies and enhances the enterprise's ability to innovate at a higher level of quality. The more attention the media receives, the more significant the impact on enterprise stakeholders. The greater the exposure of internal corporate information, the more accessible it is for stakeholders to acquire information regarding the quality of corporate innovation. This, in turn, reduces the asymmetry of information pertaining to innovation and R&D, which helps to mitigate the challenges of obtaining corporate R&D funds and therefore, facilitates additional financial support for further corporate innovation. Moreover, media monitoring has a significant influence on corporate governance. The focus of the media will bring public pressure to monitor the behaviour of corporate management and encourage it to enhance its corporate governance and decision-making ability. The efficacy of external media oversight influences the behavioral choices of enterprises and, following an increase in media activity, corporations continue to regulate their economic and social conduct to improve the effectiveness of internal resource allocation, corporate governance, and thereby increase the excellence of corporate innovation.

Secondly, the digital transformation of enterprises can alleviate financing constraints and thus enhance the quality of enterprise innovation. Enterprises that face financing restrictions and difficulties won't be able to confront external challenges effectively due to insufficient funds. Thus, they lack the incentive and capacity to improve the innovative quality. On the one hand, information asymmetry greatly influences the cost of enterprise financing. Application of digital technology in enterprises has alleviated the issue of information asymmetry between fund supply and demand entities, allowing timely access to operating and solvency conditions. This facilitates the rational allotment of credit resources and leads to improved financial resource allocation efficiency, lower financing costs, and reduction of financing restraints. Furthermore, digital technologies such as big data have transcended regional limitations in the financial sector (Song Min et al., 2021)[14], spawning unimpeded credit resource transactions amid diverse sectors and industries. Hence, opportunities for

obtaining cost-efficient external financing increase, thereby effectively supplementing the funds required for enterprise innovation. Conversely, enterprises undergo digitization, where digital technology is increasingly utilized in the production and operation phases, subsequently increasing efficiency while lowering operational and maintenance costs (Zhao Chenyu et al., 2021)[15]. Additionally, bargaining, warehouse inventory management, and supervision costs decrease (Pei Changhong et al., 2018)[16]. It follows that the greater the capital accessible to the enterprise, the more likely they are to succeed in innovation endeavors and produce high-quality innovation results.

Finally, enterprise digital transformation improves the quality of enterprise innovation by means of technological innovation. The digital transformation of enterprises can enable the development of traditional industries and accelerate their iterative upgrading. Firstly, digital technology has an aggregational effect by constructing knowledge networks that connect different enterprises and break down barriers to knowledge dissemination, thereby accelerating the speed of knowledge sharing and enhancing technological innovation abilities of enterprises. Depending on digital technology brings enterprises closer to universities and scientific research institutions while also effectively integrating fragmented resources and related technical knowledge. This promotes the extent of cooperation between industries, universities, and research institutions, provides sufficient knowledge for enterprise innovation, and thereby enhances the width and depth of such cooperation. Secondly, in the era of accelerated product turnover, enterprises must innovate continuously to respond to changing market demands. This situation puts higher requirements on the timeliness of knowledge and technology. The development and implementation of the digital economy has significantly enhanced the efficiency of data and knowledge transfer. This guarantees that the products innovated and adapted by enterprises can meet market demand promptly or even lead it. Thirdly, the digital transformation of enterprises has given them a more comprehensive digital technology infrastructure. This enables the collaborative progress of the internal R&D process and the management of the supply chain. The interconnection between intelligent manufacturing equipment within enterprises, and the development and employment of digital technology, can promptly acquire customer data and market demands. Additionally, it can advance the efficiency of enterprise product manufacturing, technological innovations, promote the correspondence between enterprise products and market demands, subsequently enhancing the quality of innovation. In summary, this paper proposes the following research hypotheses:

H1: Digital transformation of enterprises can improve the quality of corporate innovation.

3. Indicator construction, data sources and identification strategies

3.1. Indicator construction

3.1.1. Dependent variable selection

The explanatory variable in this paper is the quality of firms' innovation, noted as *innovation*. Breadth pertains to the diversity and complexity of knowledge incorporated within a firm's patents. The more complex the knowledge utilized in a patent, the higher its quality and market value. Using patent knowledge breadth to measure the quality of corporate innovation is a valid approach. This paper measures firms' innovation quality using the knowledge breadth method, as suggested by existing studies (Jie Zhang and Wenping Zheng, 2018; Aghion et al. 2019; Qiang Wu and Zhiyuan Zhong, 2023)[17-19]. This paper measures corporate innovation quality at the large group level by using the IPC classification numbers of corporate patents published by the State Intellectual Property Office (SIPO) of China, which is a common method of evaluating corporate patent quality. To determine the knowledge width of patents, this paper only considers invention patents and utility model patents as the IPC classification number system of design patents is distinct and therefore excluded.

3.1.2. Independent variable selection

This paper measures the level of digital transformation of Chinese listed companies（*digt*） using textual analysis to determine the percentage and frequency of keywords related to "digitalization" in

their annual reports, based on previous studies by Li Huamin et al. (2022), Wu Fei et al. (2021), and Zhai Huayun et al. (2021)[20-22].

Enterprise digital transformation is currently a significant strategy for high-quality enterprise development. It is often reflected in annual reports that summarize and guide operations. The language used in the annual report is a reflection of the enterprise's strategy, business philosophy, and development path. This paper uses statistical analysis of the word frequency in annual reports of listed companies to measure the degree of enterprise digital transformation. The specific processing methods involve two steps. Firstly, this paper uses the Python crawler function to fetch and organize the annual reports of A-share listed companies on SSE and SZSE. Then, it extracts all the text content with the help of Java PDFbox library. Secondly, the annual reports of listed companies are extracted by identifying high-frequency words related to enterprise digital transformation, based on two levels and five aspects of the feature words: the underlying technology application (including artificial intelligence technology, big data technology, cloud computing technology, blockchain technology) and the practical application of technology (including the application of digital technology). Finally, all the samples are processed using the Jieba function to create a data pool with word segmentation, and the collected feature word spectrum is searched, matched, and counted to form a summed word spectrum. The summed word spectrum is added to 1 and then the natural logarithm is taken. This value, known as DIGT, is used as an indicator of the level of digital transformation of the listed company. A higher DIGT value indicates a higher degree of digital transformation in the entity enterprise.

3.1.3. Control variable selection

In order to address the endogeneity problem of omitted variable interference, this paper introduces the following control variables (*Zit*) with reference to the existing literature (Fang, Hui and Huo, Qixin, 2023)[23]. Specifically, firm size (*size*), measured by the logarithm of the firm's total assets; firm age (*age*), measured by the logarithm of the firm's years of establishment; firm profitability (*roa*), measured by net profit/total assets; firm growth (*growth*), measured by the growth rate of the firm's total assets; board size (*board*), measured by the logarithm of the number of board members of the firm; and shareholding concentration (*top3*), measured by the proportion of shares held by the top three shareholders. The ratio of independent directors (*indtor*), measured by the ratio of independent directors/number of directors; the ratio of fixed assets (*fixratio*), measured by the ratio of net fixed assets/total assets; and the rate of duality (*duality*), measured by the situation where the chairman of the board and the general manager of the firm hold concurrent positions.

3.2. Modeling

We begin by constructing the baseline measurement model, drawing from prior theoretical analysis and existing literature research:

$$innovation_{it} = \alpha_0 + \alpha_1 digt_{it} + \alpha_2 Z_{it} + \mu_i + \gamma_j + \delta_t + \varepsilon_{it} \quad (1)$$

Equation (1) defines $innovation_{it}$ as the innovation quality of firmi in period t, and $digt_{it}$ as the degree of digital transformation of firmi in the same period. To address the problem of endogeneity caused by omitted variables, the paper introduces a control variable (*Zit*), as suggested in previous literature. Meanwhile, the model avoids individual heterogeneity in within-group regression, thus adding μ_i to denote the individual fixed effect that firmi does not change over time, while γ_j denotes the industry fixed effect and δ_t denotes the time fixed effect. Further, the random error term $\varepsilon_{i,t}$ in this paper clusters to the firm level to solve the systematic heteroskedasticity problem of the model.

3.3. Data sources and descriptive statistics

In this paper, the A-share listed companies in Shanghai and Shenzhen from 2011 to 2021 are selected as the research object and screened according to the following steps: (1) exclude the financial listed companies, (2) exclude the samples with missing financial data or bankruptcy, and (3) exclude

the samples marked as ST or *ST in the current year. Firm-level cluster regression is performed on the samples to eliminate the influence of differences between data groups and to adequately control for the effect of heteroskedasticity. The financial data used in the study are derived from the CSMAR database.

In Table 1, the minimum value of firms' innovation quality is 0, the maximum value is 7.1261, the mean is 0.9486, and the standard deviation is 1.2649, indicating that the innovation quality varies significantly among firms. The mean value of the level of digital transformation of enterprises is 1.4772, and the maximum and minimum values are 11.26 and 0, respectively, indicating that there is a large gap in the level of digital transformation of enterprises, and most of them have a low level of digital transformation. From other indicators, it can also be seen that there are significant differences between different listed companies in terms of enterprise characteristics and other aspects.

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max.
digt	11776	1.4772	1.3075	0.0000	11.2600
innovation	11776	0.9486	1.2649	0.0000	7.1261
size	11776	23.2848	1.4521	16.1181	30.9983
age	11776	2.8606	0.3803	0.0000	3.9890
roa	11776	0.0505	0.1000	-1.6830	7.1089
growth	11776	0.4829	12.1917	-0.9725	1137.5620
board	11776	2.1834	0.2111	0.2000	3.0445
top3	11776	37.3423	16.3648	0.2000	89.9910
indtor	11776	0.3756	0.0582	0.1818	0.8000
fixratio	11776	0.2188	0.1822	0.0000	0.9854
duality	11776	0.2147	0.4106	0.0000	1.0000

4. Empirical analysis

4.1. Benchmark regression

Table 2 presents the benchmark regression analysis of the impact of digital transformation on firms' innovation quality. Column (1) utilizes the OLS model for the benchmark regression analysis. The regression coefficient of the '*digt*' variable is positive, and the effect of digital transformation on the quality of enterprise innovation is 0.1021. The coefficient passes the significance test at the 1% level. This result is still significant at the 1% level, even after adding control variables such as enterprise size, age, and profitability in Column (2). This indicates that digital transformation contributes to the improvement of firms' innovation quality. Column (3) applies a fixed effects model to the baseline regression. The regression coefficient of the '*digt*' variable is 0.0594, which is significantly positive at the 1% level. Column (4) adds control variables and fixed effects, but the '*digt*' variable is still significantly positive at the 1% level. This confirms hypothesis H1 and indicates that enterprise digital transformation significantly contributes to the improvement of innovation quality for the enterprise.

Table 2 Benchmark regression

	OLS		Fixed effect	
	(1)	(2)	(3)	(4)
digt	0.1021***	0.0786***	0.0594***	0.0405***
	(0.0085)	(0.0084)	(0.0148)	(0.0142)
size		0.3087***		0.1849***
		(0.0102)		(0.0295)
age		-0.2075***		0.1449
		(0.0292)		(0.1754)
roa		-0.0198		-0.1417***
		(0.1095)		(0.0513)
growth		-0.0006		0.0008***
		(0.0007)		(0.0003)
board		-0.3447***		0.0996
		(0.0618)		(0.1154)
top3		-0.0030***		-0.0005
		(0.0007)		(0.0021)
indtor		0.1141		-0.0115
		(0.2217)		(0.3154)
fixratio		0.3440***		0.1920
		(0.0591)		(0.1545)
duality		0.0135		-0.0393
		(0.0250)		(0.0250)
_cons	0.7526***	-5.0629***	0.8159***	-4.0983***
	(0.0153)	(0.2478)	(0.0219)	(0.8747)
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
N	11776	11776	11758	11758
adj. R^2	0.0122	0.1370	0.7362	0.7413

Note: ***, **, and * indicate significant at 1%, 5%, and 10% confidence levels, respectively, with robust standard errors in parentheses, below.

4.2. Robustness analysis

4.2.1. Revising the method of measuring the quality of innovation.

The number of citations embodies the economic value and influence of patents and widely serves as a measure of patent innovation's quality. This paper applies the number of patent citations as a measure of enterprise innovation quality in the robustness test (Fang Hui et al., 2022)[4]. An increase in the number of patent citations indicates an increase in enterprise's innovation quality, assuming that the other variables in the model remain unchanged. The regression test is re-conducted after each modification. This paper uses the fixed effect model for analysis, and the regression results are presented in Table 3. Column (1) represents a regression model without control variables. The regression coefficient of the '*digt2*' variable is 0.0508 and it's significant at the 5% level. Column (2) includes a regression model that incorporates control variables. The regression coefficient of the '*digt2*' variable is 0.0388 and it's significant at the 10% level. The aforementioned regression results demonstrate that the digital transformation of enterprises positively affects the quality of corporate innovation.

4.2.2. Revising the method of measuring digital transformation

In the past, Wu Fei et al.'s (2021) measure was utilized. However, we now employ the method of Chenyu Zhao (2021)[15], which tabulates 99 word frequencies related to digitization across four dimensions: digital technology application, the internet business model, intelligent manufacturing, and modern information systems. This approach enables us to construct a digitization level index of

the enterprise. Column (3) refers to a regression model without control variables. The regression coefficient of the '*digt*' variable is 0.0797, demonstrating significance at the 1% level. In Column (4), we introduce control variables, and the regression coefficient of the '*digt*' variable is 0.0405, which is significant at the 1% level. All of the regression results mentioned above demonstrate that digitization can substantially enhance the quality of corporate innovation.

4.2.3. Double Clustering Robust Criterion Error

Considering the intrinsic correlation among different firms, we adjust the standard errors for dual clustering in individual and time, which can overcome the impact of problems such as autocorrelation and heteroskedasticity on statistical inference (Tao Zhang and Junchao Li, 2023)[24]. The results are shown in column (5) of Table 3. The coefficient of the core explanatory variable is 0.0405 at the 5% level, which remains significantly positive and consistent with the benchmark results.

4.2.4. Interaction fixed effect

Industries with a high level of technology or cities with advanced economic development may possess well-developed digital infrastructure, which confers an advantageous edge in the digital transformation process. To address the province-level factors that vary by year, the paper incorporates an intersection fixed effect of province and year. The robustness tests' outcomes are exhibited in column six of Table 3 and indicate significantly positive coefficients for the essential explanatory variables, matching the benchmark findings.

Table 3 Robustness test

	(1)	(2)	(3)	(4)	(5)	(6)
	Replacement of digital transformation		Replacement of the quality of innovation in enterprises		Double Clustering Robust Criterion Error	interaction fixed effect
digt2	0.0508**	0.0388*				
	(0.0211)	(0.0204)				
digt			0.0797***	0.0405***	0.0405**	0.0349***
			(0.0255)	(0.0142)	(0.0154)	(0.0135)
size		0.1900***		0.1849***	0.1849***	0.1722***
		(0.0295)		(0.0295)	(0.0271)	(0.0254)
age		0.1438		0.1449	0.1449	0.0937
		(0.1757)		(0.1754)	(0.1825)	(0.1813)
roa		-0.1399***		-0.1417***	-0.1417*	-0.0438
		(0.0513)		(0.0513)	(0.0702)	(0.0624)
growth		0.0008***		0.0008***	0.0008**	0.0006***
		(0.0003)		(0.0003)	(0.0003)	(0.0002)
board		0.1059		0.0996	0.0996	0.0656
		(0.1156)		(0.1154)	(0.1099)	(0.0987)
top3		-0.0005		-0.0005	-0.0005	0.0004
		(0.0021)		(0.0021)	(0.0021)	(0.0020)
indtor		-0.0162		-0.0115	-0.0115	0.0556
		(0.3163)		(0.3154)	(0.2712)	(0.2905)
fixratio		0.1789		0.1920	0.1920	0.1714
		(0.1545)		(0.1545)	(0.1525)	(0.1489)
duality		-0.0381		-0.0393	-0.0393	-0.0402
		(0.0251)		(0.0250)	(0.0232)	(0.0254)
_cons	0.8600***	-4.1974***	-0.7900***	-4.0983***	-4.0983***	-3.6302***
	(0.0181)	(0.8746)	(0.0376)	(0.8747)	(0.8895)	(0.7688)
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
*Pro*Year FE*	N	N	N	N	N	Y
N	11758	11758	11656	11758	11758	11758
adj. R^2	0.7356	0.7411	0.6513	0.7413	0.7413	0.7467

5. Conclusions and insights

5.1. Conclusions

This paper presents a study based on a sample of A-share listed companies in Shanghai and Shenzhen from 2011 to 2021. It examines the effect of the degree of digital transformation on corporate innovation empirically. To measure the degree of corporate digital transformation, it references the statistical word frequency method of previous studies. Additionally, this paper empirically discusses the impact of enterprise digital transformation on the quality of enterprise innovation, employing benchmark regression and robustness analysis. The study demonstrates the capability of enterprise digital transformation to enhance the quality of enterprise innovation. This discovery withstands the robustness test and remains valid even when the potential endogeneity is taken into consideration. In conclusion, digital transformation is an essential approach to enhance innovation quality in enterprises, and it has a significant positive impact on such enhancements.

5.2. Insights

The study findings propose the following policy recommendations:

Firstly, enterprises need to implement digital transformation actively, integrate data resources, introduce digital platforms, and encourage innovation. "Change leads to prosperity, but no change leads to decline." Therefore, enterprises must identify the right time and develop appropriate strategies to implement digital transformation and promote innovation in various ways. On the one hand, enterprises should implement innovation in management structure based on digital thinking, which can improve responsiveness and operational efficiency with the support of digital products. On the other hand, enterprises should also enhance their ability to leverage emerging digital technologies, such as cloud computing, to strengthen technological innovation. Moreover, enterprises need to concentrate on the development of digital platforms, which can help establish strong links with stakeholders, such as consumers or investors, and stimulate market innovation.

Secondly, the government should focus on developing digital and informatization infrastructure while creating a digital environment suitable for digital transformation. This step would lead to an improved overall allocation efficiency and provide robust support for business digitalization. Additionally, the government should foster and attract experts in related fields to achieve maximum efficacy in digital transformation. The digital economy has become a vital driver for China's economic development. The government can guide the influx of funds into digital transformation in the business sector by enacting relevant policies and reducing the threshold for enterprises to enjoy tax incentives. Furthermore, the government can support business digitalization through specialized funds, financial aid, and other means. Enterprises should increase investment in research and development, utilize digital technology to allocate resources, reduce costs and strengthen research and development in patents and technology. This will help in digital transformation.

Thirdly,the government should adopt differentiated strategies for enterprises in various industries and characteristics, improving the effect of digitally-driven innovation in line with enterprise needs. During the digital transformation and improvement of innovation quality, various enterprises must consider their strengths and weaknesses to develop appropriate strategies based on their actual situations. The government should uphold the principle of moderation and establish a scientific evaluation system to avoid any imbalance in resource allocation caused by excessive investment in digital transformation.

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