Creative Economy
2023, VOL. 7, NO. 2, 82-88
DOI: 10.47297/wspceWSP2516-251910.20230702

Can Digital Transformation Drive Business Innovation in China: The Perspective from Empirical Study

Yifan Chen

School of Economics, Henan University, Kaifeng Henan 475000, P. R. China

ABSTRACT
Enterprise innovation is an important part of China's modernization, and digital transformation (DT) is an important hand in modernization, can it promote high enterprise innovation? We use the data of all A-share listed companies from 2013-2021 to empirically test the impact of DT on enterprise innovation and verify the robustness of the conclusions. DT can significantly boost corporate innovation. Further research shows that it has a catalytic effect on SOEs, non-SOEs, manufacturing and non-manufacturing industries.

KEYWORDS
Digital transformation; corporate innovation; heterogeneity analysis; robustness test

1 Introduction

Currently, the drive for digital transformation (DT) is becoming more and more obvious and the wide application of digital information technologies such as cloud computing, Internet of Things and blockchain. Digital transformation is a deep transformation that is based on the DT of enterprises and the digital enhancement of services, and touches more deeply on the core areas of enterprises, with the main purpose of creating new business models. The "digital economy" will become an important tool for the future transformation and development of China's economy. Over the past five years, the digital economy will enable all types of production relations and social factors in China to create higher productivity benefits, thus forming a solid foundation for China's economy to grow faster in the future.

The need for DT is transforming the company's operating system and development model. The company's DT restructures, revamps, and reengineers its value system to further improve its stock of operations, increase its effectiveness, and enhance productivity. Digital production technologies can also help companies enhance their competitiveness by reducing costs and increasing efficiency, enabling them to innovate and differentiate themselves, and identify better strategic opportunities. DT also contributes to optimizing corporate management and decision-making. In addition, digital business process reengineering creates a new business model that can help companies innovate and find more innovative services, providing them with an opportunity for creative transformation and creative use, and bringing about an all-encompassing corporate rejuvenation.

* **Corresponding Author:** Email: 2879050881@qq.com

2 Literature review

There is a rich research literature on DT and business innovation, and the main types of research relevant to this paper are as follows.

The first category of literature is related to studies on digitization. With regard to digitalization, Nicholas Negroponte firstly proposed this concept, and he identified DT as the digital change in the enterprise's means of production, production relations and business model, etc [1]. Shawn Fitzgerald et al. from the theory of information technology's empowerment, argued that the digitalization of an enterprise refers to the application of digital information technology and its functions to the modern management of the enterprise [2]. The enterprise applies digital technology to all aspects of its production, operation, management and control in order to realize the digital functions of the enterprise organization. In the modern management of enterprises, that is, enterprises use digital technology in all aspects of production, operation, management and control to realize the digital functions of the enterprise organization. This includes major industrial changes in which enterprises improve the quality of their services to customers, enhance the operation process of their products, and create new business models for their companies, to promote manufacturing industry in the direction of digitization, networking, and intellectualization.

The second category of research focuses on topics related to industrial innovation. Firstly, enterprise innovation has become the main driving force for social and economic operation, and has played a great role in promoting the sustainable development of national economy. The American economist Solow affirmed that enterprise innovation at the level of production technology is one of the main factors driving economic growth from the perspectives of labor force and social capital [3]. Enterprise technological innovation may also have other connotations, not only more technological aspects of innovation knowledge and talent, as stated by Xingxin Zhao [4], is the most effective way to improve enterprise technological innovation, enhance the development performance of enterprises, and realize the transformation and upgrading, but also enterprise technological innovation contains institutional technological innovation, institutional innovation, institutional technological innovation, and so on, at multiple Moreover, enterprise technological innovation also includes institutional technological innovation, system innovation, institutional technological innovation, service technological innovation, business model technological innovation and so on.

DT provides new ideas and methods for enterprise innovation. From the perspective of anti-risk, Xi Wang et al. found that DT can improve the quality of enterprise development through innovation and risk-taking mechanisms [5]. In terms of financing constraints, Fuping Bai et al. explain that DT eases financing constraints, reduces two types of agency problems, and drives enterprises to improve technological innovation [6].

Based on the fact that digitization has been deepening and steadily advancing, this paper uses the data of all A-share listed companies from 2013-2021 to quantify the degree of DT and enterprise innovation, to empirically investigate and analyze the role of DT in promoting enterprise innovation, and to provide new insights.

3 Model setting and description of variables

3.1 Description of variables

(1) Explained variable: Innovation. It is measured by the ratio of R&D.

(2) Explanatory variable: DT lnA. According to the research of Fei Wu et al. [7], one can filter the feature words from the financial statements of enterprises through text mining tools such as Python, and take the natural logarithm of the sum of the frequency of each feature word, so as to determine

the index of DT of enterprises.

(3) Control variables：firm size, gearing ratio (Lev), net profit margin on total assets (ROA), growth rate of operating income (Growth), dual position (Dual), and the number of employees.

Shareholding of major shareholders (Top1) and growth (TobinQ) 7 variables

1. Company Size Size: natural logarithm of total assets Size=ln(total assets)

2. Lev: Lev = Total liabilities / Total assets

3. Operating income growth Growth: current year's operating income/previous year's operating income-1

4. two positions in one Dual: chairman and general manager is the same as 1, otherwise 0

5. Shareholding ratio of the largest shareholder Top1: Number of shares held by the largest shareholder/total number of shares

6. Tobin's Q: TobinQ = Tobin's Q A

3.2 Modeling

The measurement model is given below:

$Innovation_{i,t} = \alpha 0 + \alpha 1\ lnAi,t + \beta Controlsi,t + Industry + Year + \varepsilon i,t$

where i represents the firm, t represents the year, α0 is the constant term, α1, β are the coefficients of each variable, Controls is a control variable, Year is a year fixed effect, industry is an industry fixed effect, and ε is a random error term.

3.3 Data sources

The data of all A-share listed companies from 2013 to 2021 is selected, and exclude ST, financial industry and severely missing data by drawing on the study of Yang Jie et al [8]. All the continuous variables are shrink-tailed by 1% on both sides. The data, except for enterprise DT, come from the wind database.

4 Empirical studies

4.1 Descriptive statistical analysis

Table 1 indicates that the digital development of enterprises in China is not mature, the degree is generally low, and it is still in the primary stage. The large gap between the maximum and minimum indicates that the digitalization degree of enterprises is not balanced. The ratio of enterprise innovation, i.e., R&D investment to operating income, averages at 4.97, with a standard deviation of 4.896, a minimum value of 0.03, and a maximum value of 27.92. It indicates that there is a large gap between the ratio of R&D investment and total operating income of listed companies, and that the management of the enterprises attaches different importance to R&D investment, and that there is a large gap in the investment of funds. The above shows that the selection of sample companies in this paper is representative, and all types of enterprises are taken into account.

4.2 Correlation analysis

Table 2 shows that the degree of DT and enterprise innovation are significantly and positively correlated at the 1% level, which preliminarily verifies the correctness of hypothesis 1. In addition, the correlation coefficients between the main variables and the company's characteristic variables in the table are small, which basically can exclude the existence of multicollinearity in the model variables and ensure the rationality and accuracy of the model in this paper.

Table 1 Results of descriptive statistics

VarName	Obs	Mean	SD	Min	Median	Max.
lnA	22946	1.61	1.448	0	1.386294	5.214936
lnB	22946	3.15	1.202	0	3.135494	5.886104
Innovation	22946	4.97	4.896	.03	3.79	27.92
Size	22946	22.16	1.257	19.97723	21.96603	25.96644
Lev	22946	0.40	0.195	.0549989	.3846991	.861665
ROA	22946	0.05	0.064	-.19834	.044421	.212911
Growth	22946	0.17	0.331	-.469773	.11992	1.730125
Dual	22946	0.32	0.467	0	0	1
Top1	22946	0.34	0.144	.09	.3150935	.721146
TobinQ	22946	2.11	1.265	.872718	1.703861	7.809484

Table 2 Results of correlation analysis

	lnA	Innovation	Size	Lev	ROA	Growth	Dual	Top1	TobinQ
lnA	1								
Innovation	0.309***								
Size	0.040***	-0.259***	1						
Lev	-0.025***	-0.306***	0.534***	1					
ROA	-0.012*	-0.005	-0.053***	-0.394***	1				
Growth	0.044***	-0.022***	0.033***	0.013**	0.297***	1			
Dual	0.088***	0.145***	-0.197***	-0.146***	0.075***	0.041***	1		
Top1	-0.118***	-0.187***	0.164***	0.040***	0.132***	-0.019***	-0.035***	1	
TobinQ	0.073***	0.263***	-0.342***	-0.282***	0.205***	0.075***	0.063***	-0.097***	1

4.3 Benchmark regression results

In column (1), only the explanatory variables and the explanatory variables are included in the regression of control variables, the standardized regression coefficient of DT LnA(Digital) is significantly positive at the 1% level, which indicates that DT has a positive effect on innovation of enterprises; in column (2), controlling for the time fixed effect based on column (1), the standardized regression coefficient of DT LnA(Digital) is still significantly positive at the 1% level, with a coefficient of 0.889; in column (3), controlling for the industry fixed effect based on column (1), the regression coefficient of DT LnA(Digital) remains significant. The standardized regression coefficient of DT LnA (Digital) remains significantly positive at the 1% level, with a coefficient of 0.889. Column (3) controls for industry fixed effects based on column (1), and the regression coefficient of DT LnA(Digital) remains significantly positive. The regression coefficient of DT LnA(Digital) is still significantly positive, indicating that there is a good positive correlation between DT and firm innovation, and that DT will have a positive effect on firm innovation. In terms of control variables, the effects of firm size, (Lev), ROA, (Growth), dual role (Dual), shareholding ratio of the first largest shareholder (Top1), and growth (TobinQ) on the development of corporate innovation are the same as those in previous studies.

4.4 Robustness tests

This question verifies the robustness of the model by replacing the explanatory variables in the estimation method. Table 4 shows that the coefficient of the degree of DT is still greater than zero at the 1% level of significance when the measure of the degree of DT is replaced, indicating that the degree of DT is still an important contributor to the development of innovation. This conclusion is also not disturbed by the selected variables. This confirms the validity of the findings of this paper

Table 3 Benchmark regression results

	Innovation	Innovation	Innovation	Innovation
lnA	0.923***(46.80)	0.889***(44.24)	0.545***(25.09)	0.488***(22.02)
Size	-0.193***(-6.77)	-0.188***(-6.54)	0.042(1.53)	0.039(1.42)
Lev	-6.643***(-34.73)	-6.598***(-34.58)	-6.597***(-36.50)	-6.523***(-36.24)
ROA	- 10.216***(- 19.30)	- 10.428***(- 19.74)	-9.509***(- 19.40)	-9.685***(- 19.84)
Growth	-0.094(- 1.04)	-0.115(- 1.27)	-0.293***(-3.54)	-0.320***(-3.83)
Dual	0.719***(11.67)	0.690***(11.22)	0.669***(11.80)	0.627***(11.11)
Top1	-3.421***(- 17.00)	-3.274***(- 16.28)	-2.215***(- 11.84)	-2.013***(- 10.79)
TobinQ	0.642***(26.52)	0.721***(28.41)	0.578***(25.76)	0.656***(27.94)
Cons	10.468***(17.25)	10.191***(16.67)	5.596***(9.67)	5.516***(9.50)
Time fixed effect	No	Yes	No	Yes
Industry fixed effect	No	No	Yes	Yes
N	22946	22946	22946	22946
Adj. R^2	0.251	0.257	0.370	0.377

and the consistency of its predictions.

Table 4 Regression results of replacing explanatory variable measures

	Innovation
lnB	0.522*** (19.65)
Size	0.054*** (1.99)
Lev	-6.625*** (-36.74)
ROA	-9.998*** (-20.44)
Growth	-0.336*** (-4.02)
Dual	0.634*** (11.20)
Top1	-2.078*** (- 11.12)
TobinQ	0.682*** (29.03)
Cons	4.338*** (7.47)
Time fixed effect	Yes
Industry fixed effect	Yes
N	22946
Adj.R^2	0.375

4.5 Heterogeneity analysis

4.5.1 Impact of the nature of property rights

Since the differences in the nature of enterprises may have an impact on the results, we divided the research sample into two samples of state-owned and non-state-owned enterprises and ran the regression separately. The results of the study show that DT has a significant positive effect on innovation in these both two enterprises.

4.5.2 Industry nature test

Considering that the impact of DT on manufacturing and non-manufacturing industries is likely to be different, the regression shows that the coefficient for the degree of digital development is still greater than 0 at the 1% level of significance, suggesting that DT can promote the innovation in both manufacturing and non-manufacturing industries.

Table 5 Results of property rights heterogeneity test

	Innovation - State-owned enterprises	Innovation - Non-State Enterprises
lnA	0.532***(14.80)	0.481***(17.73)
Size	-0.112***(-2.89)	0.105***(2.79)
Lev	-3.419***(- 13.06)	-7.680***(-33.36)
ROA	-4.203***(-4.90)	- 11.334***(- 19.42)
Growth	-0.286**(-2.24)	-0.347***(-3.36)
Dual	0.233*(1.81)	0.582***(8.81)
Top1	- 1.780***(-6.46)	- 1.827***(-7.51)
TobinQ	0.409***(10.18)	0.745***(26.39)
Cons	6.931***(8.12)	4.610***(5.74)
Time fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
N	6381	16565
Adj. R^2	0.352	0.362

Table 6 Results of industry heterogeneity test

	Innovation - Manufacturing	Innovation - Non-Manufacturing
lnA	0.568***(24.34)	0.188***(3.35)
Size	-0.033(- 1.08)	0.248***(4.26)
Lev	-5.820***(-29.27)	-8.776***(-22.22)
ROA	- 10.419***(- 19.25)	-7.555***(-7.14)
Growth	-0.021(-0.22)	- 1.073***(-6.22)
Dual	0.585***(9.70)	0.710***(5.25)
Top1	- 1.791***(-8.75)	-2.700***(-6.51)
TobinQ	0.583***(23.39)	0.965***(16.49)
Cons	6.738***(10.46)	2.310*(1.82)
Time fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
N	16989	5957
Adj. R^2	0.233	0.552

5 Conclusions and insights

This paper takes the data of all A-share listed companies from 2013 to 2021 as the research object, uses text mining technology to quantify the DT of enterprises, explores the impact of DT on enterprise innovation, and finally obtains the following conclusions:

(1) DT has an important significance for enterprise innovation. (2) In terms of enterprise property rights and industry characteristics, the role of DT in enterprise innovation is more prominent among state-owned enterprises, non-state-owned companies and manufacturing and non-manufacturing enterprises. DT is a technological revolution and business transformation. In the transition from a "manufacturing power" to a "science and technology power", the ability of enterprises to manage digitalization and DT is the key to enterprise innovation and competitiveness upgrading.

This paper makes several recommendations to companies: The first step is to improve dynamic capabilities. In the digital era, the root causes of change come from external factors, including economic, political, legal, regulatory, environmental, and technological factors, etc. Changes in these external factors will trigger changes in the market environment and business of enterprises, which will have an impact on their competitive advantage and determine what dynamic capabilities they need to maintain their competitive advantage.

The second is to be a good digitalization engine. In a digital business environment, new value principles become empowering gas pedals for DT. Harness the power of knowledge to enhance process capabilities to deliver higher value.

The most important thing is to enhance digital technology. Digital technology can be understood and analyzed in terms of its enabling effect on business in four dimensions. First, automation; second, intelligence; third, connectivity; and fourth, feelings.

With regard to policy, the paper also makes the following recommendations: In order to steadily promote the construction of the digital economy, China must improve the coverage and level of digital economy business. At the same time, the construction of supporting infrastructures is also should be improved, and further strengthen policies and financial guarantees for the attraction of digital talents, the integration of science and technology, and the cultivation of talent systems in the field of DT, so as to support the development of the digital economy in practical terms, and to transform it into a powerful driving force for industrial and technological innovation.

About the author

Yifan Chen is undergraduate of School of Economic, Henan University, and his research field is international finance.

References

[1] Negroponte N. (1995). El mundo digital. Ediciones B, 1995.

[2] Fitzgerald M, Kruschwitz N, Bonnet D, e alt(2014). Embracing digital technology: A new strategic imperative. MIT Sloan Management Review, 55(2): 1-12.

[3] Solow, R.M. (1957) Technical change and the aggregate production function. Review of Economics and Statistics, 39: 312-320.

[4] Zhao X. (2022). Research on the mechanism of the impact of technological diversification on the innovation performance of manufacturing enterprises. Thesis of University of Electronic Science and Technology, 6: 1-164.

[5] Wang X, Chen X, Cao Jet al. (2023). Impact of digital transformation on high-quality development of enterprises--an enterprise innovation and risk taking perspective. Science and Technology Progress and Countermeasures, 1-10.

[6] Bai F, Dong K, Liu D. (2023). How digital transformation affects technological innovation of enterprises: An empirical analysis based on the perspective of financing constraints and agency problems. Accounting Friends, 10:124-133.

[7] Wu F, Hu H, Lin H, et al. (2021). Corporate digital transformation and capital market performance- Empirical evidence from stock liquidity. Management World, 37(7): 130-144, 10.

[8] Yang J, Ma C, Liu Y. (2022). The impact of digital transformation on corporate innovation. Statistics and Decision Making, 38(23): 180-184.