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How Digital Transformation Affects Manufacturing Innovation in the Yangtze River Economic Belt

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Abstract:

This research seeks to explore how regional digital transformation synergistically impacts manufacturing innovation in the Yangtze River Economic Belt. By analyzing panel data from publicly traded A-share firms from 2016 to 2022, the study systematically explores how regional digital transformation drives manufacturing innovation within the Yangtze River Economic Belt. The results reveal that digital transformation plays a major role in boosting the innovation capabilities of the manufacturing sector, with collaborative policies and regional resource sharing serving as key intermediaries in this process.

Keywords: digital transformation, Yangtze River Economic Belt, manufacturing industry, synergies

1. Introduction

As global information technology evolves quickly, the transition to digital has become a crucial strategy for modernizing and transforming the global manufacturing industry. General Secretary Xi Jinping highlighted the need to speed up digital transformation and proposed a strategic plan for building a fully digital China, as outlined in the "14th Five-Year Plan" and the "2035 Vision Goals" from the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China.

Today, the Yangtze River Economic Belt is a core area for advancing China's digital economy. Maximizing the influence of these key urban centers can boost regional economic coordination, drive national economic growth and optimize industrial structure, while also advancing green development, improving infrastructure, and elevating quality of life. Recently, the economic landscape of the Yangtze River Economic Belt has been advancing steadily, with the economic system undergoing continuous updates. As of 2024, the Yangtze River Economic Belt contributes 46.9% to the national economy, up by 3.8 percentage points from 2016. Obviously, the Yangtze River Economic Belt has bolstered the developing Chinese economic . As a crucial pillar and strategic driver of the Chinese economy, it plays a key part in digital transformation, with various regions there making notable progress. However, despite notable achievements in digital transformation across regions, differences in infrastructure, uneven distribution of innovation resources, and varying industrial structures can lead to significant disparities in effects. These differences will impact regional economic progress, challenge the steady growth of the manufacturing sector, and somewhat limit the advanced digital transformation in the Yangtze River Economic Belt's manufacturing sectors. Therefore,it is key to achieving high-quality development in the current stage to understand how

the efficiency of digital transformation in the Yangtze River Economic Belt's manufacturing sector and the influence of policy coordination and resource sharing affect this process.

2. Literature Review

In China, many scholars have actively explored the effects of digital transformation on manufacturing innovation and have conducted substantial research on this topic. Miao Xiaonan (2024) suggested that the adoption of digital technologies by enterprises significantly enhances their innovation capabilities, and Zhao Jianfeng (2023) also proposed to pay attention to innovation efficiency and the balance between input and output; Wan Wei (2024) found through research on supply chain relationships that digital transformation promotes technological innovation in enterprises, while Yu Jiang (2024) proposed that digital transformation improves the overall production and operational workflows of enterprises; Wu Chuanqing (2022) discovered that the digital transformation of the Yangtze River Economic Belt has indirectly facilitated the green growth of the manufacturing industry. Xu Li (2023) explained that digital transformation has enhanced how efficiently enterprises utilize resources and altered their financing models.

In summary, digital transformation not only exerts a strong positive influence on manufacturing innovation directly, but also generates numerous indirect effects. However, many studies seldom address the synergistic effects of digital transformation across regions. This will make us underestimate the effects and impacts of regional synergy on digital transformation and upgrading, indirectly undermining the internal driving force of regional development, increasing obstacles to resource sharing, thereby restricting the high-level advancement of the manufacturing sector, and further widening the development gap between regions .As a result, this article intends to explore the effects of digital transformation across regions in the Yangtze River Economic Belt on innovation within various manufacturing industries. By constructing a theoretical framework and empirical model, it explores the regional synergy relationship of digital transformation among regions and its implementation approaches.

3. Conceptual Framework and Research Assumptions

3.1 Analysis of Innovation Diffusion Theory

The theory of innovation diffusion was proposed by American scholar Everett Rogers, which explains how a new idea or technology spreads among members of a social group through specific channels, and divides innovation diffusion into five stages: knowledge phase, persuasion phase, decision phase, implementation phase, and confirmation phase. The theory of innovation diffusion suggests that once digital transformation in the manufacturing sector of the Yangtze River Economic Belt surpasses a certain critical threshold, it undergoes a qualitative change and then spontaneously spreads throughout the organization or society, thereby enhancing the innovation capability of manufacturing enterprises. Based on this, this article proposes hypothesis one:

H1: Enhanced digital transformation levels across regions have notably boosted the innovation capacity of the manufacturing sector.

3.2 Analysis of Technology Organization Environment Framework (TOE Framework)

The TOE framework is developed by L G. Tornatzky and M Fleischer proposed that whether a company adopts a technology depends on its analysis of the application scenarios of the technology, and divides its influencing factors into technical factors, organizational factors, and environmental factors. The TOE framework illustrates that, firstly, digital transformation technologies are more compatible with existing systems compared to traditional methods and offer greater benefits for the development of manufacturing. Secondly, large enterprises, particularly in manufacturing, are more likely to invest in and oversee digital transformation. Finally, as an economic hub, the policies and market competition within the Yangtze River Economic Belt may stimulate the manufacturing industry's digital shift.

By integrating innovation diffusion theory, the TOE framework sheds light on the critical role of digital technologies and regional policy coordination in driving high-quality development within the manufacturing sector. It helps us comprehend the rationale and feasibility of digital transformation from both internal factors and external environmental conditions. Based on this, Hypothesis 2 is proposed in this paper:

H2: Inter-regional policy coordination serves as a mediator in the process of digital transformation.

4. Study Framework

4.1 Data Origins

The data in this article is drawn from the annual reports of listed companies, focusing on manufacturing enterpris-

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es within the Yangtze River Economic Belt, covering 11 provinces and cities, and the A-share markets from 2016 to 2022. After excluding samples of *ST, ST, PT, and those missing key data, regression analysis was applied for empirical investigation.

4.2 Variable Setting

4.2.1 Explained variable: Manufacturing innovation capability

This article uses the proportion of operating profit from manufacturing firms in the Yangtze River Economic Belt for the current year as a weight to calculate the region's weighted average R&D investment, thereby assessing the innovation capability of the sector.

4.2.2 Core explanatory factor: Manufacturing digitalization

This paper uses the Internet penetration rate and basic digital technology application of listed manufacturing firms in the Yangtze River Economic Belt as key indicators, with the current year's operating profit proportion in the region serving as the weight.

Control variables: degree of digital transformation B (weighted average reflecting high-level investments and applications, with weights based on manufacturing profit proportions), digitalization level (weighted average of manufacturing sector digitalization), comprehensive index of digital financial benefits, regional GDP (in billions), high-quality manufacturing development index, marketization index (covering government-market relations, non-state economic development, maturity of product and factor markets, market intermediaries and legal environment), and frequency of digital economy policy terms (interaction value of digital economy-related terms' frequency and distribution in Yangtze River Economic Belt policies).

Table 1 Summary of Key Variable Statistics

Factor	Variable Identifier	Average	standard deviation	Lowest Value	Highest Value
Degree of digital transformation A	diA	164.884	199.927	7.218	849.08
Degree of digital transformation B	diB	358.298	415.747	25.553	1843.202
Digitization level	di	46237.077	55426.551	3698.065	240903.14
Digital Inclusive Finance Composite Index	hp	328.552	61.492	209.455	460.691
Regional GDP	gdp	41059.382	23602.33	11792.4	122089.3
High-quality manufacturing development index	de	.175	.137	.06	.564
Government-market relations	govmar	7.07	.939	5.397	9.112
Non-state economic development	inna	11.269	1.656	6.075	14.714
The level of development of the product market	mak1	7.101	1.575	4.402	9.4
Maturity of product and factor markets	mak2	11.417	3.366	4.034	19.328
Market intermediaries and legal environment	mid	11.391	3.958	2.515	18.974
R&D investment amount	mo	2379434.5	2531662.2	167236.2	10379695
Frequency of Digital Economy Policy Words and Phrases	NUM	689.623	685.814	33	2597

4.3 Model Assumptions

$$mo_{it} = \beta_0 + \beta_1 diA_{it} + \sum \gamma_k Control_{it} + \alpha_i + \lambda_t + \epsilon_{it} \quad (1)$$

Among them, i represents manufacturing in the Yangtze River Economic Belt, t denotes the year, and $\beta_0, \beta_1 and \gamma_k$ are constants. The key independent variable, diA_{it}, captures how digitally transformed the manufacturing sector i is across various provinces and cities in the Yangtze River Economic Belt during period t. The dependent variable mo_{it} represents the R&D investment amount for region i within the Yangtze River Economic Belt at time t. $\alpha_i and \lambda_t$ represent the dummy variables for industry-specific and time-specific fixed effects in the various manufacturing sectors across the Yangtze River Economic

Belt, while ϵ_{it} denotes the random disturbance term.

5. Analysis of Empirical Results.

5.1 Standard Regression

Through the Hausman test comparison, it was demonstrated that the individual fixed effects model is a better fit for this data structure, as seen in Table 2. Among them, Model (1) and Model (2) use marketization indices (govmar, inna, mak1, mak2, mid) and regional economic development status (GDP, hp, de) as control variables to assess how digital transformation in the Yangtze River Economic Belt affects manufacturing innovation.

Table 2 shows that digital transformation significantly boosts R&D investment in the manufacturing sector, particularly in regions with well-developed product markets.However, growth in the non-state-owned sector has significantly hindered R&D investment, possibly due to reduced innovation efficiency from uneven resource distribution across regions. Mean-while, regional economic development influences digital transformation more significantly than differences in regional marketization indices.

Overall, in the Yangtze River Economic Belt, the process of digital transformation has significantly enhanced manufacturing innovation. This indicates that it is crucial for the Yangtze River Economic Belt to fully utilize its advantages, enhance digital transformation awareness and infrastructure construction, boost manufacturing competitiveness, drive regional economic development to a higher standard, and enhance its standing in the national economy. Therefore, the hypothesis of this article has been confirmed.

Table 2 How Digital Transformation in the Yangtze River Economic Belt Affects Manufacturing Innovation

	Framework (1)	Framework (2)
diA	3112.2**	3177.6**
	(3.19)	(3.26)
govmar	-278165.5	
	(-1.29)	
inna	-429632.1*	
	(-2.47)	
mak1	534493.7***	
	(3.81)	
mak2	132798.6	
	(1.32)	
mid	-187298.4**	
	(-2.73)	
hp		42092.7**
		(2.80)
gdp		35.13
		(1.38)
de		14583195.3***
		(3.77)

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_cons	2887701.2	-12336224.2**
	(1.13)	(-3.61)
N	77	77

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. T-values are shown in parentheses, and this applies throughout.

5.2 Robustness Check

To ensure the reliability of the regression model and confirm that the results are not influenced by particular explanatory variables, this paper conducts the following robustness tests:

Firstly,for the regression model where the marketization index is used as a control variable, this study opts to use diB and di as alternative variables for diA in the regression. The outcomes are displayed in Framework (2) and Framework (3) of Table 3. It is evident that digital transformation continues to exert a significant positive influence on R&D investment in the manufacturing sector within the Yangtze River Economic Belt. After using cluster robust standard error processing on the initial Framework (1), as in Framework (4), digital transformation still brings significant positive effects. Therefore, under this testing model, the findings of this study are robust.

Table 3 Robustness Test with Marketization Index as a Controlling Factor.

	Framework (1) (Initial Model (1))	Framework (2) (DiB replaces DiA)	Framework (3) (Replace diA with di)	Framework (4) Cluster robust standard error
diA	3272.7**			6859.6**
	(3.18)			(3.20)
diB		2714.9***		
		(4.55)		
di			5436072.6*	
			(2.44)	
govmar	-517529.7*	-447209.0*	-428996.7*	-49320.5
	(-2.49)	(-2.33)	(-2.36)	(-0.24)
inna	-625470.0***	-498961.5**	-443610.1**	-225949.3
	(-3.73)	(-3.11)	(-2.86)	(-1.24)
mak1	559499.8***	458371.8**	349161.6*	251715.6
	(3.79)	(3.28)	(2.48)	(1.87)
mak2	71512.8	-1815.6	-49431.8	495292.6*
	(0.69)	(-0.02)	(-0.52)	(2.31)
_cons	5328872.2*	4802688.7*	5436072.6*	-3298693.5*
	(2.10)	(2.04)	(2.44)	(-2.50)
N	77	77	77	77

Secondly, for the regression model with regional economic development status as the control variable, this article still chooses diB and di as substitute variables for diA, with the outcomes presented in Table 4. It is found that diB and di continue to significantly boost R&D investment in the manufacturing sector of the Yangtze River Economic Belt, aligning with the earlier conclusion and confirming its significance and robustness.

Table 4 Robustness Test with Regional Economic Development Status as a Controlling Factor.

	Framework (1)	Framework (2)	Framework (3)
	(DiA serves as the explanatory variable)	(diB serves as the explanatory variable)	(di functions as the explanatory variable)
diA	3177.6**		25.09***
	(3.26)		(5.09)
diB		2769.1***	
		(4.58)	
di			25.09***
			(5.09)
hp	42092.7**	38737.6**	30563.1*
	(2.80)	(2.83)	(2.21)
gdp	35.13	1.088	-22.53
	(1.38)	(0.04)	(-0.82)
de	14583195.3***	13827189.8***	13578744.7***
	(3.77)	(3.84)	(3.89)
_cons	-12336224.2***	-10636040.0**	-7964794.7*
	(-3.61)	(-3.35)	(-2.41)
N	77	77	77

5.3 Mechanism verification

To further study and analyze the effect of policy synergy on digital transformation in the process of digital transformation, this paper selects the frequency of digital economic policy words and as mediating variables in the Yangtze River Economic Belt region, and constructs the following mediating effect model:

$$mo_{it} = \beta_0 + \beta_1 diA_{it} + \sum \gamma_k Control_{it} + \alpha_i + \lambda_t + \epsilon_{it} \quad (2)$$

$$NUM_{it} = \delta_0 + \delta_1 diA_{it} + \sum \theta_k Control_{it} + \alpha_i + \lambda_t + \epsilon_{it} \quad (3)$$

$$mo_{it} = \eta_0 + \eta_1 diA_{it} + \eta_2 NUM_{it} + \sum \mu_k Control_{it} + \alpha_i + \lambda_t + \epsilon_{it} \quad (4)$$

NUM_{it} is the interaction value between the frequency and distribution of policy terms related to the digital economy within the Yangtze River Economic Belt, reflecting the frequency and distribution of these terms across the region and years in the Yangtze River Economic Belt. δ_1 reflects the impact of digitalization on the mediating variables, η_1 shows the direct influence of digitalization on manufacturing innovation in the Yangtze River Economic Belt, and the product of $\delta_1 and \eta_2$ represents the mediating effect of digitalization in enhancing manufacturing innovation within the Yangtze River region.

Framework (2) in Table 5 shows that an increase in the degree of digital transformation will significantly have a reverse impact on collaborative policies. Given the economic conditions in the Yangtze River Economic Belt, the primary cause of this outcome lies in the imbalanced

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resource allocation and economic disparities across the regions, leading to collaborative policies experiencing fatigue and delayed effects. In addition, the complex regional structure of each region leads to the phenomenon of asynchronous development progress in the upstream, midstream, and downstream. Combined with framework (3), collaborative policies exert a markedly negative influence on manufacturing innovation, thereby confirming the second hypothesis of this paper.

Table 5 The Outcomes of The Mediation Effect Evaluation.

		Framework(1)	Framework (2)	Framework (3)
		(Direct Effect Model)	(Mediating variable equation)	(Innovation Performance Equation)
diA		4701.2***	-2.680**	3775.8**
		(4.15)	(-3.26)	(3.15)
NUM				-345.3*
				(-2.02)
mak2		-83934.8	-75.07	-109859.8
		(-0.86)	(-1.06)	(-1.14)
hp		3735.7	5.487	5630.7
		(0.92)	(1.86)	(1.38)
gdp		117.0***	0.0325	128.2***
		(3.89)	(1.49)	(4.30)
_cons		-3467258.2***	-1146.9**	-3863332.1***
		(-5.94)	(-2.71)	(-6.42)
N		77	77	77

6 Research conclusions

The study reveals that digital transformation significantly enhances the innovation capabilities of the manufacturing sector in the Yangtze River Economic Belt, with this finding holding up in robustness and endogeneity tests. Additionally, while regional policy coordination serves as an intermediary in digital transformation, disparities in regional development, local implementation capabilities, and adaptation levels can lead to negative effects on the sector's digital transformation.

References

[1] Lu Ruichen, Wang Youyuan, Yan Gaoshang. Research on the Coupling and Coordination of Digital Economy and High Quality Development of Manufacturing Industry - Taking the Yangtze River Economic Belt as an Example [J]. Science and Technology Square, 2024, (01): 30-38. DOI: 10.13838/j.cnki.kjgc. 2022.01.001

[2] Lai Yongfeng, Liu Xing. Good deeds in promoting high-quality development of the Yangtze River Economic Belt [N]. Economic Daily, February 21, 2024 (001) DOI:10.28425/n.cnki.njjrb.2024.001028.

[3] Yu Kaizhi, Shi Yao, Feng Jiahan. The Impact of Digital Economy on the Upgrading of Industrial Structure in the Yangtze River Economic Belt [J]. Journal of Finance and Economics, 2024, (02): 119-135

[4] Zhang Zaijie, Yang Weifang. Comprehensive Evaluation and Analysis of Digital Transformation Capability in Manufacturing Industry - Taking the Yangtze River Economic Belt as an Example [J]. Times Economy and Trade, 2023, 20 (12): 163-167. DOI: 10.19463/j.cnki.sdjm.2023.12.027

[5] Moni. Research on the Path to Enhancing the Green Technology Innovation Capability of Manufacturing Industry in the Yangtze River Economic Belt [J]. Modern Industrial

Economy and Informatization, 2023, 13 (10): 74-77. DOI: 10.16525/j.cnki. 14-1362/n.2023, 10.024
[6] Fu Yimao, Zhang Chenyi, Wang Huanfang, et al. Research on the spatial correlation structure and effects of high-quality development of manufacturing industry in the Yangtze River Economic Belt [J]. Resource Development and Market, 2023, 39 (11): 1479-1488
[7] Gao Lili, Lu Changyun, Zhu Jiaming. Empirical Study on Digital Economy Empowering High Quality Development of Manufacturing Industry under the New Development Pattern: Taking the Yangtze River Economic Belt as an Example. Journal of Natural Sciences, Harbin Normal University, 2023, 39 (04): 21-32
[8] Zhang Wenying, Ge Jianhua. Analysis of the Impact and Spatial Heterogeneity of the Digital Economy Environment in the Yangtze River Economic Belt on the Transformation and Upgrading of Manufacturing Industry [J]. Journal of Soochow University (Philosophy and Social Sciences Edition), 2023, 44 (03): 51-62. DOI: 10.19563/j.cnki.sdzs.2023.03.006
[9] Wu Chuanqing, Meng Xiaoqian. Research on the Impact of Digital Transformation of the Yangtze River Economic Belt on Green Development of Manufacturing Industry [J]. Journal of Nantong University (Social Sciences Edition), 2022, 38 (06): 37-47
[10] Zhao Jianfeng, Chang Tianxing. Can digital transformation improve the efficiency of enterprise innovation investment? [J] Journal of Shanxi Economic Management Cadre College, 2023, 31 (04): 1-9+17
[11] Yujiang, Bai Yutong, Meng Qingshi, et al. Study on the Impact of Digital Transformation Strategy on Enterprise Digital Innovation Performance [J]. Research Management, 2024, 45 (04): 1-11. DOI: 10.19571/j.cnki. 1000-2995.2024.04.001
[12] Miao Xiaonan. Research on the Impact of Digital Transformation on Innovation Capability of Manufacturing Enterprises [J]. Industrial Innovation Research, 2024, (06): 13-18
[13] Xu Li. Research on the Impact of Digital Transformation on Enterprise Innovation [J]. Finance and Accounting Communication, 2023, (16): 78-83. DOI: 10.16144/j.cnki. issn1002-8072.2023.16.017
[14] Wu You. Participation in Venture Capital Management, Digital Transformation, and Enterprise Innovation [J]. Shanghai Economic Research, 2023, (05): 78-92. DOI: 10.19626/j.cnki. cn31-1163/f.2023.05.002
[15] Wan Wei, Liu Zheng. Digital Transformation, Supply Chain Optimization, and Enterprise Technological Innovation [J/OL]. Science and Management, 1-14 [2400-07-29] http://kns.cnki.net/kcms/detail/37.1020.G3.20240419.1000.004.html.