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The Impact of Digital Inclusive Finance in Shandong Province on the Optimization of Employment Structure—Research Based on the Perspectives of Regional Innovation and Entrepreneurial Activity

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Abstract: *Based on panel data from 16 cities in Shandong Province from 2011 to 2021, this article empirically studies the impact of the development of digital inclusive finance on the optimization of employment structure in Shandong Province, based on regional innovation and entrepreneurial activity. Research has found that, overall, digital inclusive finance can significantly promote the optimization of China's employment structure; Digital inclusive finance can more effectively promote the development of the tertiary industry and optimize the employment structure in regions with active innovation and entrepreneurship; Regional heterogeneity analysis shows that compared to economically underdeveloped areas in Shandong Province, the impact of digital inclusive finance on employment structure in developed areas is significant and positive. Based on the above conclusions, this article proposes some suggestions: China should integrate digital inclusive finance with policy frameworks, actively promote its development, and closely integrate the development of digital inclusive finance with employment issues; In the process of promoting the development of digital inclusive finance, it is necessary to strengthen support for innovation and entrepreneurship to achieve more efficient optimization of employment structure.*

Keywords: *digital inclusive finance; Optimization of employment structure; Regional innovation activity; Regional entrepreneurial activity*

1. Introduction

Employment is the most significant aspect of people's livelihood. Currently, China's employment structure faces challenges such as a shortage of working-age individuals amidst an aging population, a mismatch between the professional qualities of job seekers and job requirements, a discrepancy between the labor supply structure and the social demand structure, and prominent regional structural employment contradictions. As the third technological revolution deepens, digital inclusive finance based on digital technology has gradually become the main force in the development of China's inclusive finance industry, providing opportunities to alleviate structural employment contradictions.

2. Literature review and research hypotheses

2.1 The direct effect of digital inclusive finance on employment structure

The employment structure in this article is measured by dividing the proportion of employment in the secondary industry by the proportion of employment in the tertiary industry. Digital inclusive finance aims to provide more people with inclusive financial services, alleviate credit constraints, and impact employment structure. The specific impact on industrial structure is manifested as facilitating the transfer of labor in the primary industry and expanding the employment scale in the tertiary industry.[1] (Zhang Lu, Liu Xichuan et al., 2023) In addition, from the perspectives of financial development scale and depth, digital inclusive finance promotes the development of the tertiary industry and has a restraining effect on the primary and secondary industries.[2](He Guosheng, Geng Zhechen, et al., 2021) Based on this, the first research hypothesis of this article is proposed:

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H1: Digital inclusive finance positively promotes the optimization of employment structure.

2.2 The indirect effects of digital inclusive finance on employment structure

2.2.1 Regional entrepreneurial activity

This study represents the regional entrepreneurial activity as the natural logarithm of the number of new startups per hundred people. Based on existing literature analysis, digital inclusive finance can promote residents' entrepreneurship through three main pathways: firstly, digital inclusive finance can improve the efficiency of entrepreneurs in accessing financial services. Digital inclusive finance, with its advantages of wide coverage, low financing costs, and convenient use, promotes the healthy operation of small and medium-sized enterprises and has a significant positive impact on residents' entrepreneurship[3]. (Luo Xinyu et al., 2021). Secondly, scholars have found through their research on Chinese residents' consumption that digital inclusive finance has driven the development of productive and consumer service industries, thereby creating more entrepreneurial opportunities.[4] (Yi Xing Jian, Zhou Li, 2018) Finally, digital inclusive finance can optimize the entrepreneurial environment for residents. The impact of digital inclusive finance on residents' entrepreneurship relies on favorable external conditions, and digital inclusive finance contributes to economic growth, thereby forming entrepreneurial activity and generating more employment opportunities and forms.[5](Yang Yuwen and Zhang Yunxia, 2023) Based on the above analysis, the research hypothesis of this article is proposed:

H2: Regional entrepreneurial activity positively regulates the optimization effect of digital inclusive finance on employment structure.

2.2.2 Regional innovation activity

At the level of enterprise innovation, digital inclusive finance can alleviate financing constraints, promote enterprise innovation, and this intermediary effect is more significant in small and medium-sized enterprises.[6](Wan Jiayu et al., 2020) And digital inclusive finance can suppress enterprise innovation risks and promote enterprise innovation.[7](Ma Hong, Li Xiaoping, 2022) In addition, the better the economic conditions in the region, the higher the marginal utility of the innovation brought by digital inclusive finance.[8](Han Xianfeng et al., 2019) The improvement of regional innovation capability through digital inclusive finance varies depending on factors such as urban geographical location and administrative divisions. Empirical results show that the innovative role of digital inclusive finance is stronger in the central and western regions, as well as in areas with weaker innovation capabilities.[9] (Xu Ziyao et al., 2020) Based on the above analysis, the research hypothesis of this article is proposed:

H3: Regional entrepreneurial activity positively regulates the optimization effect of digital inclusive finance on employment structure.

3. Variables, and Model Construction

3.1 Data sources and sample cleaning

This paper uses the data of prefecture level cities, which are mainly from the statistical yearbook of cities in Shandong Province and the digital inclusive financial index of Peking University. In view of the availability of data, this paper selects 16 prefecture level cities in 11 years from 2011-2021 as the sample period for research. After the corresponding logarithmic processing of the data, the missing values are eliminated for the whole row. Finally, 174 valid samples were obtained.

3.2 Variable definition

The core variables of this article include independent variables, dependent variables, moderating variables, and control variables, with specific definitions and measurement methods as follows. The independent variable is Digital Inclusive Finance (DF), which is measured by the natural logarithm of the Peking University Digital Inclusive Finance Index to reflect the level of digital finance development in various prefecture level cities. The dependent variable is employment structure (IndS), measured by the ratio of the output value of the tertiary industry to that of the secondary industry. In robustness analysis, the alternative measure of the dependent variable is the proportion of employment in the tertiary industry in each prefecture level city, in order to further verify the robustness of the model. The moderating variables include regional entrepreneurial activity (Found) and regional innovation activity (INV), where

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regional entrepreneurial activity is represented by the natural logarithm of the number of new ventures per hundred people, and regional innovation activity is measured by the natural logarithm of the number of patent applications in each prefecture level city.

To control for other potential influencing factors, this article introduces multiple control variables. Economic level (Eco) is measured by the natural logarithm of the year-end gross domestic product of each prefecture level city; The population level (Pop) is expressed by the number of registered residence population in the city (in 10000 people); The level of marketization is measured by the proportion of urban private and individual employees to urban employment; The Internet penetration rate (Internet) uses the number of Internet users per hundred people to reflect the degree of network development in various regions. Through the above variable settings, this article aims to comprehensively analyze the impact of digital inclusive finance on employment structure, while considering the moderating effect of entrepreneurship and innovation activity within the region.As shown in Table 1.

Table 1: Variable Definition Table

Variable type	Variable definition	Variable Name	Data measurement
independent variable	Digital Inclusive Finance	DF	Natural logarithm of Peking University Digital Inclusive Finance Index
dependent variable	employment structure	IndS	Output value of tertiary industry/output value of secondary industry
Adjusting variables	Regional entrepreneurial activity	Found	The natural logarithm of the number of new startups per hundred people
	Regional innovation activity	INV	The natural logarithm of the number of patent applications
control variable	Economic level	Eco	Natural logarithm of year-end gross domestic product
	Population level	Pop	Registered residence population of the city (10000 people)
	Marketization level	Market	Urban private and individual employees/urban employed personnel
	Internet penetration	Internet	Internet users per 100 people

3.3 Model construction

Based on the theoretical analysis in the previous section, this article combines the research needs to construct a panel data model to explore the impact of digital inclusive finance in Shandong Province on employment structure. The benchmark model is set as follows:

$$\mathrm{IndS}_{it} = \beta_0 + \beta_1 \mathrm{DF}_i + \gamma X_{it} + \sigma_t + \varepsilon_{it} \quad (1)$$

Among them, IndS is the dependent variable and the DFexplanatory ε_{it}variable. At the same time, the model adds a Xcontrol variable representing the time effect $\sigma_t$and a random disturbance term representing the interference amplitude of other uncontrollable random factors.

4. Empirical analyses

4.1 Descriptive statistics

Table 2 shows the descriptive statistical results of the selected variables in Shandong Province. The mean of employment structure (IndS) is 0.981, the standard deviation is 0.308, the minimum value is 0.346, and the maximum value is 1.787, indicating significant differences in employment structure among various prefecture level cities in Shandong Province. The proportion of the tertiary and secondary industries in some prefecture level cities is relatively low, reflecting significant differences in industrial structure and economic development levels among different regions, especially in economically underdeveloped areas where the proportion of the secondary industry is higher.

The average value of the Digital Inclusive Finance Index (DF) is 5.144, with a minimum value of 3.507 and a maximum value of 5.77, indicating that there is a significant gap in the development level of digital inclusive finance among various prefecture level cities in Shandong Province. Some prefecture level cities have relatively lagging digital finance development, which is related to the differences in

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economic development and financial infrastructure construction between prefecture level cities.

Table 2: Descriptive Statistical Results

Variable	Obs	Mean	Std. Dev.	Min	Max
IndS	174	.981	.308	.346	1.787
DF	174	5.144	.506	3.507	5.77
Pop	174	6.302	.494	5.228	7.092
Market	174	1.232	1.451	.335	8.594
Internet	174	187.129	458.487	6.687	2873.629
Eco	174	11.072	.467	9.839	12.165
INV	174	8.813	1.2	5.472	12.41
Found	174	.852	.328	.299	1.699

4.2 Correlation analysis

According to table 3, there is a significant positive correlation between digital inclusive finance (DF) and employment structure (IndS), with a correlation coefficient of 0.550, and it is significant at the 1% significance level. This indicates that with the development of digital inclusive finance, the employment structure in Shandong Province has been optimized, and the proportion of the tertiary industry relative to the secondary industry has increased. This result is consistent with the widespread application of digital inclusive finance, especially the significant development in economically developed coastal areas.

The correlation coefficient between regional innovation activity (INV) and employment structure is 0.544, significant at the 1% level, indicating that the improvement of innovation capability can promote the optimization of employment structure. The correlation between regional entrepreneurial activity (Found) and employment structure is 0.632, and is significant at the 1% significance level, indicating that an increase in entrepreneurial activity can significantly promote the optimization of employment structure.

The correlation between other variables also reflects the indirect impact of factors such as economy, innovation, and marketization on employment structure and digital inclusive finance. In particular, the correlation coefficient between digital inclusive finance and regional entrepreneurial activity is as high as 0.760, indicating that the popularization of digital inclusive finance can not only optimize employment structure, but also significantly promote regional entrepreneurial activities.

Table 3: Statistical Results of Correlation Analysis

Variables	(IndS)	(DF)	(Pop)	(Market)	(Internet)	(Eco)	(INV)	(Found)
IndS	1.000							
DF	0.550***	1.000						
Pop	0.416***	-0.024	1.000					
Market	0.403***	0.269***	0.266***	1.000				
Internet	0.431***	0.394***	0.024	0.422***	1.000			
Eco	0.086	0.441***	-0.537***	0.082	0.205***	1.000		
INV	0.544***	0.430***	0.300***	0.282***	0.258***	0.335***	1.000	
Found	0.632***	0.760***	-0.031	0.402***	0.444***	0.613***	0.611***	1.000

*** p<0.01, ** p<0.05, * p<0.1

4.3 Benchmark regression analysis

According to table 4, Model (1) only includes the independent variable of digital inclusive finance, while Model (2) adds multiple control variables on top of the independent variable. The regression results indicate that digital inclusive finance (DF) has a significant and positive impact on employment structure (IndS). In model (1), the regression coefficient of digital inclusive finance is 0.380, and it is significant at the 5% significance level (t-value of 2.062), indicating that the improvement of digital inclusive finance has a positive effect on optimizing employment structure. In model (2), after introducing control variables such as population level, marketization level, Internet penetration rate and economic level, the coefficient of digital inclusive finance increases to 0.738, and is significant at the 1% significance level (t value is 3.044), indicating that the positive impact of digital inclusive finance on employment structure is more significant after controlling other factors.

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In addition, the goodness of fit of model (2) is 0.628, compared to model (1)'s 0.410, indicating that the addition of control variables significantly improves the explanatory power of the model, and the overall model can explain 62.8% of the changes in employment structure. The F-statistic shows that the F-value of model (1) is 4.251, significant at the 5% significance level, while the F-value of model (2) is 19.794, significant at the 1% significance level, indicating that the overall explanatory power of model (2) is stronger. Both models controlled for fixed year effects to eliminate the impact of macroeconomic fluctuations in different periods on the results.

Table 4: Regression Results of Benchmark for Optimizing Employment Structure through Digital Inclusive Finance

	(1)	(2)
	IndS	IndS
DF	0.380**	0.738***
	(2.062)	(3.044)
Pop		0.274***
		(6.678)
Market		0.009
		(0.719)
Internet		0.000**
		(2.062)
Eco		-0.012
		(-0.189)
_cons	-0.976	-4.440***
	(-1.028)	(-4.941)
N	174	174
R2	0.410	0.628
F	4.251	19.794
Year Fixed	YES	YES

*** p<0.01, ** p<0.05, * p<0.1

4.4 Adjustment effect analysis

According to table 5, the results of the moderation effect analysis in the table demonstrate the moderating effects of regional innovation activity and regional entrepreneurship activity on the optimization of employment structure through digital inclusive finance. The interaction terms (Interact1 and Interact2) are mainly used to analyze the impact of the interaction effect between digital inclusive finance and these two moderating variables on employment structure.

In model (1), the direct impact coefficient of digital inclusive finance (DF) on employment structure (IndS) is 0.738, and it is significant at the 1% significance level (t-value of 3.044), indicating that the improvement of digital inclusive finance can significantly optimize employment structure. This result is consistent with the aforementioned benchmark regression, indicating that digital inclusive finance has significantly promoted the development of the tertiary industry and optimized the employment structure.

In model (2), an interaction term between digital inclusive finance and regional entrepreneurial activity (Interact1) was added, with a coefficient of 0.001 and significant at the 1% significance level (t-value of 5.452). This indicates that regional entrepreneurial activity significantly moderates the positive impact of digital inclusive finance on employment structure.

In model (3), an interaction term between digital inclusive finance and regional innovation activity (Interact2) was added, with a coefficient of 0.001 and significant at the 1% significance level (t-value of 5.621). This indicates that regional innovation activity also has a significant positive moderating effect on the optimization of employment structure in digital inclusive finance.

From the perspective of other control variables in the model, population level (Pop) still has a significant positive impact on employment structure in models (1) and (2), but its effect is no longer significant in model (3). This may be due to the strong moderating effect of regional innovation and entrepreneurial activity, which partially weakens the direct impact of population on employment structure. Internet penetration rate (Internet) is significant in model (1), indicating that it has a positive impact on employment structure, but its impact is not significant after adding interactive terms. The economic level (Eco) is significant and negative in models (2) and (3), indicating that regions with higher

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levels of economic development have slower transformation of their employment structure towards the tertiary industry, possibly because the secondary industry still dominates in these regions.

From the perspective of model fitting, the addition of interaction terms significantly improves the explanatory power of the model. The R^2 value of model (2) is 0.687, compared to the R^2 value of 0.628 in model (1), indicating that the moderating effect of regional entrepreneurial activity significantly enhances the explanatory power of the model. The R^2 value of model (3) is 0.690, which further increases, indicating that the regulatory effect of regional innovation activity on digital inclusive finance also significantly enhances the explanatory power of employment structure optimization.

Table 5: Results of the moderation effect of regional innovation and entrepreneurial activity

	(1)	(2)	(3)
	IndS	IndS	IndS
DF	0.738***	0.972***	0.453**
	(3.044)	(4.281)	(1.989)
Pop	0.274***	0.178***	0.080
	(6.678)	(4.264)	(1.572)
Market	0.009	-0.009	0.008
	(0.719)	(-0.729)	(0.678)
Internet	0.000**	0.000	0.000
	(2.062)	(1.085)	(1.421)
Eco	-0.012	-0.265***	-0.272***
	(-0.189)	(-3.483)	(-3.594)
Interact1		0.001***	
		(5.452)	
Interact2			0.001***
			(5.621)
_cons	-4.440***	-2.439***	0.186
	(-4.941)	(-2.697)	(0.160)
N	174	174	174
R2	0.628	0.687	0.690
F	19.794	24.449	24.955
Year Fixed	YES	YES	YES

*** p<0.01, ** p<0.05, * p<0.1

4.5 Stability and endogeneity treatment

According to table 6, Model (1) serves as the benchmark regression result, showing a significant positive impact of digital inclusive finance on employment structure. The regression coefficient of digital inclusive finance is 0.738, and it is significant at the 1% significance level (t-value of 3.044), indicating that the development of digital inclusive finance can significantly optimize the employment structure and promote an increase in the proportion of the tertiary industry relative to the secondary industry.

In model (2), potential endogeneity issues are addressed by introducing lagged digital inclusive finance (L.DF) as an instrumental variable. The coefficient of digital inclusive finance with a lag of one period is 0.722, and it is significant at the 1% significance level (t-value of 2.853), indicating that the lag effect of digital inclusive finance still has a significant positive impact on the optimization of employment structure. The lag of one period in digital inclusive finance indicates that the long-term development of digital inclusive finance has a sustained positive effect on employment structure and a stable optimization effect.

In model (3), the dependent variable is replaced with the proportion of employment in the tertiary industry (SecS) to further test the robustness of the results. The results show that the impact of digital inclusive finance on the proportion of employment in the tertiary industry is significant, with a lagged coefficient of 6.838 and significant at the 1% significance level (t-value of 5.034). This indicates that digital inclusive finance not only plays a role in improving industrial structure, but also increases the proportion of employment in the tertiary industry, thereby promoting its development.

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Table 6: Robustness and endogeneity treatment

	(1)	(2)	(3)
	IndS	IndS	SecS
DF	0.738***		
	(3.044)		
Pop	0.274***	0.277***	4.678***
	(6.678)	(6.441)	(3.128)
Market	0.009	0.010	0.783*
	(0.719)	(0.817)	(1.768)
Internet	0.000**	0.000*	0.003**
	(2.062)	(1.928)	(2.458)
Eco	-0.012	-0.010	-9.630***
	(-0.189)	(-0.138)	(-5.711)
L.DF		0.722***	6.838***
		(2.853)	(5.034)
_cons	-4.440***	-4.343***	89.251***
	(-4.941)	(-4.802)	(3.747)
N	174	158	158
R2	0.628	0.616	0.479
F	19.794	18.619	27.958

*** p<0.01, ** p<0.05, * p<0.1

4.6 Heterogeneity analysis

According to table 7, in model (1), in regions with lower economic levels, the impact of digital inclusive finance on employment structure is not significant, and the coefficient of digital inclusive finance is -0.010, which has not reached a significant level. On the contrary, in model (2), in regions with higher economic levels, the impact of digital inclusive finance on employment structure is significant and positive, with a coefficient of 3.679 and significant at the 1% significance level (t-value of 5.432).

From the perspective of controlling variables, population level (Pop) has a significant positive impact on employment structure in regions with higher economic levels, with a coefficient of 0.227 (t-value of 4.020), indicating that population growth can significantly promote the development of the tertiary industry in these regions, while the impact of population is not significant in regions with lower economic levels.

Table 7: Heterogeneity Analysis of Economic Development Level

	LowEco	HighEco
	IndS	IndS
DF	-0.010	3.679***
	(-0.048)	(5.432)
Pop	0.068	0.227***
	(1.638)	(4.020)
Market	0.009	0.019
	(0.784)	(1.084)
Internet	-0.000	0.000**
	(-0.340)	(2.046)
Eco	-0.282***	-0.357***
	(-3.356)	(-3.332)
_cons	3.546***	-15.871***
	(3.341)	(-5.614)
N	86	88
R2	0.846	0.735
F	10.325	27.548
Year Fixed	YES	YES

*** p<0.01, ** p<0.05, * p<0.1

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5. Conclusion and Implications

This article is based on panel data from 16 cities in Shandong Province from 2011 to 2021, and empirically studies the impact of the development of digital inclusive finance on the optimization of employment structure in Shandong Province from the perspectives of regional innovation and entrepreneurial activity. The research results indicate that digital inclusive finance has a significant positive impact on the employment structure of Shandong Province, which helps to promote the development of the tertiary industry and optimize the regional employment structure; The moderation effect analysis shows that the regional entrepreneurial activity and regional innovation activity significantly enhance the positive effect of digital inclusive finance on optimizing employment structure; The heterogeneity analysis results indicate that the impact of digital inclusive finance on employment structure varies significantly in regions with different levels of economic development.

Based on the above conclusions, the following three policy recommendations can be proposed: firstly, to promote the close integration of digital inclusive finance and employment policies. The government should encourage micro, small and medium-sized enterprises to use digital inclusive financial policies to solve financing difficulties and other problems, strengthen job training for rural labor, and guide the orderly transfer of labor. Second, the government should provide more ways for enterprises to innovate and start businesses. The government should introduce more policies and measures to encourage entrepreneurship and innovation, such as providing tax incentives, entrepreneurship subsidies, innovation funds, etc., to stimulate market vitality, establish and improve innovation and entrepreneurship incubation platforms, provide financing, technology, market and other support for startups and small and micro enterprises, and enhance regional entrepreneurship and innovation activity. Thirdly, different digital inclusive finance policies should be formulated based on the economic development status of each region, further stimulating the ability of digital inclusive finance to optimize employment structure.

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