Regional Innovation of Sustainable Development Model of Digital Finance

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Abstract. This article is based on Chinese provincial panel data from 2011 to 2019, by using the fixed effects model to empirically test the relationship between the development of digital inclusive finance and regional innovation output and further inspection east Midwest heterogeneity effect of regional innovation, after robustness inspection in explaining variables by replacing the basic conclusion remains valid. The results show that the development of digital inclusive finance directly promotes regional innovation output, and the promotion effect has significant regional heterogeneity.

Keywords: Digital financial inclusion · Regional innovation · Heterogeneity test

1 Introduction

At present, the research on the relationship between the development of digital inclusive finance and regional innovation output is still in its infancy, and scholars are more concerned about the impact of digital finance development on the income gap between urban and rural areas, independent entrepreneurship, economic growth, and enterprise innovation output, while there are fewer studies on regional innovation output related to digital finance. Most scholars focus on the relationship between digital financial development and enterprise innovation, and rarely explore the impact of digital financial development on regional innovation from a macro perspective.

2 Research Hypotheses

H1: The development of digital financial inclusion can directly promote the improvement of regional innovation level. H2: The breadth of digital financial inclusion can directly promote the improvement of regional innovation level. H3: The depth of use of digital financial inclusion can directly promote the improvement of regional innovation level. H4: The degree of digitalization of inclusive finance can directly promote the improvement of regional innovation level. H5: There is significant regional heterogeneity in the impact of digital financial inclusion development on regional innovation output.

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3 Study Design

3.1 Model Settings

Through theoretical mechanism analysis, sets the following empirical models (1):

$$inno_{it} = \beta_0 + \beta_1 DF_{it} + \beta_2 X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

$inno_{it}$ the explanatory variable represented in the model - regional innovation; DF_{it} indicates the level of digital financial inclusion development in the i region in the t period; When testing the influence of the digital financial inclusion index, the three component indices were regressed sequentially as core explanatory variables. X_{it} is a series of control variables in the model that affect the explanatory variables; μ_i is an individual fixed effect; ε_{it} is a random perturbation term.

3.2 Variable Selection and Description

Table 1 describes the core variable settings in this topic.

3.3 Data sources and Statistical Descriptions

Panel data from 30 provinces (except Tibet) in China from 2011 to 2019 were selected as the research object. The regional innovation data of the dependent variable are derived from the China Science and Technology Statistical Yearbook, the independent variable data is derived from the Peking University Digital Financial Inclusion Index, and the control variable data is from the China Statistical Yearbook and China Science and Technology Statistics Yearbook. Table 2 shows the analysis results.

4 Empirical Analysis

4.1 Correlation Analysis

Correlation analysis is used to test whether there is a correlation and correlation between variables, a correlation coefficient of less than 0 is negatively correlated, greater than 0 is positively correlated, its absolute value is less than 0.5 is weakly correlated, between 0.5 and 0.7 is moderately correlated, and more than 0.7 is highly correlated. Table 3 shows the results of variable correlation analysis.

Regional innovation and digital financial inclusion and its three dimensions (coverage breadth, depth of use, and digitalization) are significantly positively correlated at the statistical level of 1%, and the hypothesis 1 is preliminarily verified. In addition, the control variables (per capita GDP, urbanization rate, intellectual property protection, openness, R&D input intensity) were all significantly positively correlated with regional innovation at the statistical level of 1%.

Table 1. Study variable setting

Types of variables	name	Represents a symbol	meaning
The variable being explained	Regional innovation	inno	Number of patent applications (items)
Explanatory variables	Digital financial inclusion	DF	Digital Financial Inclusion Development Index
	Breadth of coverage	range	Digital Financial Inclusion Coverage Breadth Index
	Use depth	deep	Digital financial inclusion uses the Depth Index
	Degree of digitalization	digital	Financial Inclusion Digitalization Index
Control variables	Level of economic development	per_gdp	Per capita GDP of each region (billion yuan)
	Innovation investment intensity	rd_eco	R&D internal expenditure as a percentage of GDP by region (%)
	Urbanization rate	urban	Proportion of urban population to total population at the end of the year (%)
	Intellectual Property Protection	intelligent	Technology market turnover by region as a percentage of GDP (%)
	Openness to the outside world	open	Total imports and exports as a percentage of GDP (%)

Source: Compiled by the author himself

4.2 Regression Analysis

Tables (1) and (2) in Table 4 list the estimated coefficient values and significance of the digital financial inclusion index in the absence and inclusion of control variables. Columns (3)–(8) replace the core explanatory variables with digital financial inclusion indices: the estimated coefficient values and significance after coverage breadth, depth of use, and degree of digitization.

As can be seen from column (1) of Table 4, the estimated coefficient of digital financial inclusion is significantly positive at the statistical level of 1%, that is, hypothesis 1 in this paper is valid. In column (2), it can be seen that the economic development level, urbanization rate, intellectual property protection and R&D input intensity of the

Table 2. Descriptive statistical analysis results of variables

variable	mean	standard deviation	minimum	maximum	Observations
lnpatent	10.64	1.41	6.60	13.60	270
lnDF	5.15	0.67	2.91	6.02	270
lnrange	5.00	0.83	0.67	5.95	270
lndeep	5.13	0.65	1.91	6.09	270
lndigital	5.46	0.72	2.03	6.14	270
lnrd_talent	11.17	1.18	8.30	13.60	270
lnper_gdp	10.81	0.43	9.71	12.01	270
lnurban	−0.57	0.20	−1.05	−0.11	270
lnintelligent	−5.18	1.35	−8.59	−1.81	270
lnopen	−1.82	0.98	−6.12	0.44	270

Source: Stata 15.0 software processing results, the same below

Table 3. Results of variable correlation analysis

	lnpatent	lnDF	lnrange	lndeep	lndigital	lnper_gdp	lnurban	lnintelligent	lnopen	lnrd_eco
lnpatent	1.000									
lnDF	0.424***	1.000								
lnrange	0.432***	0.974***	1.000							
lndeep	0.510***	0.958***	0.932***	1.000						
lndigital	0.206***	0.889***	0.808***	0.793***	1.000					
lnper_gdp	0.580***	0.535***	0.567***	0.548***	0.295***	1.000				
lnurban	0.493***	0.427***	0.475***	0.445***	0.165***	0.919***	1.000			
lnintelligent	0.429***	0.282***	0.281***	0.286***	0.149**	0.454***	0.528***	1.000		
lnopen	0.573***	0.139**	0.174***	0.212***	-0.08	0.591***	0.648***	0.246***	1.000	
lnrd_eco	0.795***	0.293***	0.318***	0.349***	0.069	0.712***	0.733***	0.714***	0.615***	1.000

Note: *, **, *** * indicate significant at the statistical levels of 10%, 5% and 1%, respectively.

control variables all have significant promotion effects on regional innovation output, while the degree of openness to the outside world is not significant. The results in columns (3)–(8) show that the digital financial inclusion component index also has a significant contribution to regional innovation output, supporting Assumptions 2, 3, and 4.

4.3 Testing for Regional Heterogeneity

In order to further investigate the impact of digital financial inclusion on regional innovation, this paper divides each province (municipality directly under the central government) into three regions: eastern, central, and western, and conducts group regression to test the impact of regional heterogeneity. Fixed effects were selected for regression coefficient estimation and the results are shown in Table 5.

Table 4. Estimation results of full-sample basic regression

variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	lnpatent	lnpatent	lnpatent	lnpatent	lnpatent	lnpatent	lnpatent	lnpatent
lnDF	0.612***	0.258***						
	(25.25)	(6.76)						
lnrange			0.494***	0.200***				
			(23.72)	(6.43)				
lndeep					0.645***	0.264***		
					(23.69)	(7.17)		
lndigital							0.482***	0.119***
							(16.71)	(4.07)
lnper_gdp		0.402***		0.509***		0.440***		0.478***
		(2.73)		(3.54)		(3.08)		(2.96)
lnurban		2.121***		1.742***		2.212***		3.372***
		(4.09)		(3.16)		(4.37)		(6.58)
lnintelligent		0.0536*		0.0620**		0.0415		0.0524*
		(1.88)		(2.15)		(1.47)		(1.74)
lnopen		-0.00311		-0.00251		0.00893		-0.00492
		(-0.10)		(-0.08)		-0.28		(-0.14)
lnrd_eco		0.590***		0.698***		0.632***		0.509***
		(4.06)		(4.74)		(4.39)		(3.28)
_cons	7.489***	8.989***	8.173***	8.453***	7.328***	8.743***	8.007***	9.205***
	(59.56)	(4.9)	(77.64)	(4.6)	(52.07)	(4.83)	(50.39)	(4.64)
F	215.14	77.63	194.18	76.31	175.69	73.04	145.81	79.73
R-squared	0.7274	0.8288	0.7019	0.8261	0.7013	0.8322	0.5387	0.8089
N	270	270	270	270	270	270	270	270

Note: (1) Source: Stata 15.0 software processing results; (2) *, **, *** * indicate significant at 10%, 5% and 1% statistical levels, respectively; (3) The value of t is in parentheses.

Table 5 epitomize regional heterogeneity in the relationship between digital inclusive financial policies and regional innovation. It can be seen from the results of columns (2) and (6) in the table that the development of digital inclusive finance has significantly promoted the regional innovation output in the eastern and western regions, while it can be seen from (4) that the development of digital inclusive finance in the central region has no significant role in promoting regional innovation output, and the promotion effect of digital inclusive finance on regional innovation output in the three regions is specifically manifested as "western > eastern > Middle", supporting hypothesis 5.

4.4 Robustness Test

In order to ensure the validity of the regression results, this paper conducts the following robustness test: the explanatory variables are replaced with invention patents in the patent applications, and the number of patent applications is used as a proxy variable for regional innovation output. China's patents are divided into three types: invention patents, utility model patents, and design patents, of which invention patents can better reflect innovation, and the return results are shown in Table 6.

Table 5. Tests for regional heterogeneity

region variable	eastern		Central		westward	
	(1)	(2)	(3)	(4)	(5)	(6)
	lnpatent	lnpatent	lnpatent	lnpatent	lnpatent	lnpatent
lnDF	0.609***	0.119*	0.554***	0.0329	0.651***	0.398***
	(13.93)	(1.83)	(11.11)	(0.57)	(18.25)	(6.33)
lnper_gdp		0.894***		0.398		−1.421***
		(5.43)		(1.28)		(−3.52)
lnurban		0.503		3.121***		6.664***
		(0.64)		(2.66)		(4.87)
lnintelligent		0.122**		0.132**		0.000319
		(2.51)		(2.63)		(0.01)
lnopen		0.0456		-0.179**		0.00518
		(1.42)		(-2.28)		(0.06)
lnrd_eco		1.038***		0.974***		0.112
		(3.87)		(4.27)		(0.51)
_cons	8.250***	5.716***	7.852***	12.79***	6.493***	28.01***
	(35.45)	(2.77)	(30.6)	(3.37)	(35.72)	(5.43)
F-value	286.91	114.07	52.79	37.78	175.16	74.15
R-squared	0.6905	0.848	0.6622	0.8972	0.7928	0.8687
N	99	99	72	72	99	99

Note: (1) Source: Stata 15.0 software processing results; (2) *, **, *** * indicate significant at 10%, 5% and 1% statistical levels, respectively; (3) The value of t is in parentheses.

The robustness test results show that the regression coefficients of digital inclusive finance of the core explanatory variables are significantly positive at the level of 1%, and the development of digital inclusive finance in China significantly promotes the increase of regional innovation output, which is consistent with the basic regression results in Table 4, and also improves the coefficients of explanatory variables in the model, which proves that the regression conclusions obtained in this paper are robust.

Table 6. Robustness test

variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	lninno	lninno	lninno	lninno	lninno	lninno	lninno	lninno
lnDF	0.632***	0.344***						
	(25.05)	(7.73)						
lnrange			0.508***	0.259***				
			(23.13)	(7.06)				
lndeep					0.648***	0.280***		
					(21.55)	(6.21)		
lndigital							0.530***	0.227***
							(19.17)	(6.86)
lnper_gdp		0.697***		0.851***		0.839***		0.632***
		(4.06)		(5.03)		(4.79)		(3.47)
lnurban		0.871		0.432		1.310**		2.549***
		(1.44)		(0.66)		(2.11)		(4.4)
lnintelligent		0.0485		0.0593*		0.0356		0.0466
		(1.45)		(1.75)		(1.03)		(1.37)
lnopen		0.0293		0.0301		0.0424		0.0251
		(0.77)		(0.78)		(1.08)		(0.65)
lnrd_eco		0.248		0.388**		0.297*		0.0848
		(1.46)		(2.24)		(1.69)		(0.48)
_cons	6.268***	2.083	6.989***	1.31	6.196***	1.306	6.632***	3.565
	(47.83)	(0.97)	(62.96)	(0.6)	(39.84)	(0.59)	(43.59)	(1.59)
F-value	195.95	50.21	172.16	48.10	143.35	43.81	158.72	54.52
R-squared	0.7242	0.7821	0.6912	0.7745	0.6601	0.7651	0.6059	0.7723
N	270	270	270	270	270	270	270	270

Note: (1) Source: Stata 15.0 software processing results; (2) *, **, *** * indicate significant at 10%, 5% and 1% statistical levels, respectively; (3) The value of t is in parentheses

5 Conclusions

First, whether from the digital inclusive financial index or from the breadth of coverage, depth of use and degree of digitalization, the positive impact of digital inclusive finance on China's regional innovation output is significant. Second, there is obvious regional heterogeneity in the development of digital inclusive finance for regional innovation outputs, and the promotion effect of digital inclusive finance on regional innovation outputs in the eastern, central, and western regions is specifically manifested as "western > eastern > Central" .

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