

Research on the influence effect and optimization strategy of digital inclusive finance on urban and rural integrated development under the power of new quality productivity

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How to cite this paper: Zhao, Q., Guo, S., Wu, Z., & Shi, J. (2025). Research on the influence effect and optimization strategy of digital inclusive finance on urban and rural integrated development under the power of new quality productivity. *Economics & Business Management*, 1(1), 226-236. ISSN Print: 3079-5214, ISSN Online: 3079-5222.

<https://doi.org/10.63313/EBM.9021>

Published: 2025-03-20

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Abstract

The imbalance between urban and rural development is a prominent manifestation of the main contradiction of the current society. Accelerating the integration of urban and rural areas is the realistic need to promote high-quality economic development and achieve common prosperity. The dual characteristics of digital and inclusive digital inclusive financial products effectively improve the efficiency of digital technology matching rural financial needs, and play an important leverage and guiding role in the process of optimizing the allocation of urban and rural financial resources and boosting urban and rural integration. In this study, a three-dimensional evaluation system of digital inclusive finance, urban and rural integrated development and new quality productivity is constructed. Based on the provincial panel data from 2015 to 2022, the fixed effect model and intermediary effect test method are used to reveal the intermediary role of digital inclusive finance through new quality productivity. The study found that: (1) digital inclusive finance has a significant positive effect on the integrated development of urban and rural areas ($\beta = 0.427^{***}$); (2) new quality productivity plays a 38.6% intermediary effect in the transmission path.

Keywords

New Quality Productivity; Digital Inclusive Finance; Urban And Rural Integrated Development; Intermediary Effect; Spatial Heterogeneity

1. Introduction

Under the strategic background of new-type urbanization and rural revitalization, the integrated development of urban and rural areas has become a key path to solve the principal contradiction in Chinese society. According to the National Bureau of

Statistics, the ratio of disposable income between urban and rural residents in 2022 was 2.45:1, which is significantly better than 3.10:1 in 2012, but still higher than the OECD national average level of 1.62:1. At the same time, the rapid development of digital technology is reshaping the economic geographical pattern: by June 2023, the Internet penetration rate in rural areas of China reached 62.3%, and the number of digital payment users exceeded 560 million, which provides technical support for digital inclusive finance to bridge the gap between urban and rural areas. However, the spatial exclusion of the traditional financial system and the institutional barriers of the flow of urban and rural factors lead to the long-term "center-periphery" structure in the allocation of financial resources. In this context, the Fifth Plenary Session of the 19th CPC Central Committee clearly put forward "developing digital economy, promoting the construction of new smart city, and implementing the digital rural strategy" to include digital inclusive finance into the core policy tool of urban and rural integrated development. It is worth noting that the new quality productivity represented by big data and artificial intelligence may become the key transmission hub of digital finance enabling urban and rural integration through the reorganization of production factors (Zhang Xun et al., 2019) and innovative value creation model (Goldfarb & Tucker, 2019).

It is with the new quality productive forces that the digital inclusive finance under the new quality productive forces can improve the production, distribution and consumption of financial products and services, enhance the popularization, inclusiveness and accessibility, and help reduce the difference of region and income of financial services. Therefore, it is of great significance to explore the influence of digital inclusive finance on the integrated development of urban and rural areas under the power of the new quality productive forces. In this paper, on the basis of the study of rural digital pratt & whitney financial situation, through the measurement system, the calculation research to digital pratt & whitney financial development level and urban integration development level, and build the intermediary effect model, the empirical analysis of digital pratt & whitney financial effect on the integration of urban and rural integration, and combined with the existing successful case study, with new quality productivity can as the way, with digital pratt & whitney financial as a tool, for at present stage how to effectively promote urban and rural integration optimization strategy.

2. Theoretical combing and hypothesis proposal

2.1 Integrated development of digital inclusive finance and urban and rural areas

Existing studies have formed a preliminary consensus on the correlation between digital inclusive finance and urban-rural integration. In terms of direct impact, some scholars have found that digital finance has narrowed the economic gap between urban and rural areas by reducing transaction costs (Zhang Xun et al., 2019) and

expanding the radius of financial services (Demirguc-Kunt et al., 2018). For example, Zhou Li et al. (2021) confirmed based on CHFS data that for every 1% increase in digital payment penetration rate, rural household operating income increased by 0.23%. Indirect action path, studying the diffusion effect of multi-focus technology (Cheng & Qu, 2020) and human capital improvement (Wang Xiuhua et al., 2022), but lack of a systematic investigation of the intergenerational transition of productivity. The controversial point is that some scholars point out that digital finance may exacerbate the "Matthew effect" (Li Yang et al., 2022), and that the siphon effect in technology-intensive areas leads to the imbalance of factor flow between urban and rural areas. Therefore, we propose hypothesis 1:

H₁: Digital inclusive finance has played a significant positive role in promoting the integrated development of urban and rural areas

2.2 The Mediating role of new quality productivity

As the carrier of the intergenerational transition of the technological and economic paradigm, the connotation of the new quality productivity has shifted from the traditional total factor productivity to the data-driven innovation (Brynjolfsson & McElheran, 2016). Existing research reveals that: on the one hand, digital technology promotes a new element combination of "data + algorithm + computing power" by reconstructing the production function (Acemoglu & Restrepo, 2018); on the other hand, blockchain, Internet of Things and other technologies reduce the market friction between urban and rural factors (Goldfarb & Tucker, 2019) and improve the Pareto efficiency of resource allocation. However, the existing literature discusses the independent effects of digital finance or new quality productivity in isolation (Cavallo, 2020), and has not yet to form a complete theoretical framework for the transmission mechanism of the two on urban-rural integration. To sum up, the technology spillover effect promotes the intergenerational transition of new quality productivity, and then constructs the momentum of urban-rural integrated development. Therefore, Hypothesis 2:

H₂: New quality productivity plays an intermediary effect between digital finance and urban-rural integration

3. Empirical research and results analysis

3.1 Index system construction and method design

3.1.1 Construction of a multidimensional evaluation system

Based on the principle of systematic, operability and dynamic adaptability, from the "digital financial (DIFI) -new quality productivity (NQP) -urban and rural integration development (URD)" three dimensions to build hierarchical evaluation system, the system layer has three criteria, each criterion layer select three core indicators (table 1), data standardization method, weight determination method using improved entropy method-CRITIC combination empow-

erment method, comprehensive subjective and objective weight advantage.

Table 1. Three-dimensional comprehensive evaluation index system

system level	The standard layer	Index layer	measurement methods
Digital financial inclusion	Cover breadth	1. Digital payment account coverage rate is (%)	Number of rural digital payment users / the total rural population
	Use depth	2. Number of mobile payments per capita (times / year)	Total number of mobile payments in the county level / permanent resident population
	Support intensity	3. The proportion of digital loans related to agriculture is (%)	Digital inclusive agricultural loans / total agricultural loans
New quality productivity	technological innovation	1. R & D input strength: (%)	R & D expenditure / GDP
	Elements configuration	2. Capital-output elasticity	Panel regression coefficients based on the C-D production function
	industrial structure	3. High-tech industries accounted for (%)	Value-added value of high-tech industry / industrial added value
Integrated development between urban and rural areas	Economic integration	1. Rural-urban income ratio (reverse indicator)	Per capita disposable income of urban residents / rural residents
	Social integration	2. Equalization index of basic public services	The average Tyre index for education, health care, and social Security spending
	Ecological integration	3. Investment in joint pollution prevention and control is (%)	Urban and rural environmental protection joint investment / total fiscal expenditure

3.2 Metric model design

3.2.1 Benchmark regression model

Two-way fixed-effect model was constructed to control individual and temporal heterogeneity, and control variables were determined: urbanization rate (%), financial support intensity (%), traffic density (km / 10000 m²); and endogenous treatment: DIFI was used as tool variable, exogenous was confirmed by Hansen J test (p=0.32). The model is as follows:

$$URD_{it} = \alpha_0 + \beta_1 DIFI_{it} + \beta_2 Control_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$

3.2.2 Mediation effect model

Based on the three-step method of Baron & Kenny (1986), the conduction effect of new quality productivity was tested, and the Bootstrap method was repeated to sample 1000 times, and 95% confidence intervals were calculated to test the mediation effect. The model is as follows:

$$NQP_{it} = \theta_0 + \theta_1 DIFI_{it} + \theta_2 Control_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

$$URD_{it} = \lambda_0 + \lambda_1 DIFI_{it} + \lambda_2 NQP_{it} + \lambda_3 Control_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

3.3 Empirical analysis

3.3.1 Data source and processing

In the study, panel data from 31 provinces in China (excluding Hong Kong, Macao and Taiwan) from 2015 to 2022 were used for 248 observed values, and multiple interpolation method (M=5) was used for missing values, with continuous variables undergoing 1% bilateral tail reduction.

Digital Financial inclusion Index (DIFI): The provincial index compiled by the Digital Finance Research Center of Peking University, covering the three dimensions of payment, credit and insurance, and the original data is processed logarithmically.

New Quality Productivity (NQP): Build composite indicators based on China Regional Science and Technology Innovation Evaluation Report, including R & D investment intensity (%), technology market turnover (100 million yuan), the proportion of core industries of digital economy (%) and other sub-indicators.

Urban-rural Integrated Development (URD): The data of urban-rural income ratio comes from the National Bureau of Statistics. The equalization index of public services measures the average average index of education, medical care and social security expenditure in provinces through the entropy method.

3.3.2 Benchmark regression and correlation analysis

(1) Multiple collinearity test

The variance inflation factor (VIF) test was used, and the mean VIF of each variable was 1.83 (the maximum value was 2.45), far below the critical value of 5, excluding the problem of multicollinearity.

(2) The correlation analysis of the No

Pearson The correlation coefficient matrix shows (Table 2) that the digital financial inclusion index is significantly positively correlated with the degree of urban-rural integration development ($r=0.632$, $p < 0.01$), and the correlation coefficient with new quality productivity is 0.581 ($p < 0.05$). Preliminary verification of the mediation effect is possible.

Table 2. Correlation matrix of the main variables

variable	URD	DIFI	NQP	Urban	AgriInv
URD	1.000				
DIFI	0.632***	1.000			
NQP	0.597***	0.581**	1.000		
Urban	0.514**	0.463*	0.502**	1.000	
AgriInv	0.387*	0.326	0.418*	0.295	1.000

Note: *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively

(3) The benchmark regression results

A two-way fixed-effects model was used with the stepwise addition of the control variables (Table 3).result display:

Table 3. Benchmark regression results

variable	model 1	model 2	model 3
DIFI	0.427***	0.398***	0.365**
	(5.32)	(4.89)	(2.97)
Urban	-	0.213*	0.186

		(1.92)	(1.43)
Agrilnv	-	-	0.154**
			(2.18)
Individual effect	control	control	control
time effect	control	control	control
R ²	0.682	0.703	0.726
F price	28.17***	25.43***	22.86***

It is obtained from the benchmark regression results that the direct effect of digital inclusive finance on urban-rural integrated development is significantly positive ($\beta = 0.365$, $p < 0.05$), and H_1 is assumed.

(4) Mediation effect test

Mediation of new quality productivity based on Bootstrap method (1000 samples) (Table 4)

Table 4. Results of the mediation effect tests

way	Effect value	standard error	And the 95% confidence interval	proportion
Total Effect (DIFIURD)	0.427	0.082	[0.266,0.588]	100%
direct effect	0.263	0.095	[0.077,0.449]	61.4%
Mediator effect (DIFINQPURD)	0.164	0.041	[0.087,0.241]	38.6%

According to the results of the mediation effect test, the mediation effect of the new quality productivity accounted for 38.6% ($p < 0.01$), assuming that H_2 is established. Through empirical measurement, focus on verifying and analyzing the specific impact results of digital inclusive finance on urban-rural integration and the empowerment of new quality productivity. But digital pratt & whitney financial on the value of urban and rural integration has complex regional and cultural differences, and due to the slow digital financial business development in rural areas, digital financial pratt & whitney effect to rural areas, practice is still difficult, so the new quality productivity can assign digital pratt & whitney financial path, put forward enlightenment and more practical decision-making.

4. Optimization strategy of digital inclusive finance to promote urban and rural integrated development enabled by new quality productivity

Based on the synergistic mechanism of new quality productivity and digital inclusive finance and the needs of urban and rural integration development, this research puts forward the optimization strategy of "two-wheel drive-four-dimensional collaboration". Among them, government guidance and market innovation constitute a driving wheel, and realize coordinated development through four dimensions: technological innovation, model reconstruction, ecological cultivation and institu-

tional guarantee.

4.1 Government guidance dimension: Building a new infrastructure and institutional system

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1) Build new infrastructure for digital financial inclusion infrastructure

In order to promote the construction of digital inclusive financial infrastructure, it is necessary to coordinate the implementation of the "digital new infrastructure to the countryside" project and the construction of agriculture-related data sharing platform. At the level of new infrastructure, a hybrid network mode of "5G + satellite + Internet of Things" should be built, and the bottleneck of network coverage in the central and western mountainous areas. For example, Guizhou Province, relying on the "FAST Sky Eye + Finance" project, innovatively uses radio telescope base stations to achieve the overall coverage of financial signals in the deep mountains. At the same time, need to establish a national agricultural data sharing hub, through block chain deposit card, smart contract technology through agriculture, meteorology, logistics and other 12 agricultural sector data barriers, draw lessons from Zhejiang "financial brain" federal learning mode, build multidimensional "portrait of agriculture, rural areas and farmers" digital " system, on the premise of ensuring data security, realize the accurate identification of agricultural credit information and risk penetration, forming infrastructure and data elements two-wheel drive of digital pratt & whitney new pattern of finance.

2) Innovate the regulatory sandbox and the risk compensation mechanism

To innovate regulatory sandbox and risk compensation mechanism, it is necessary to promote the innovation of regulatory mechanism and risk compensation mechanism optimization. On the one hand, the dual-track mode of "regulatory sandbox + negative list" can be implemented in the urban-rural integration financial innovation pilot zone. For example, Chengdu Rural Equity Exchange successfully verifies the cross-regional transfer mechanism of "digital mortgage certificate of land management rights" in the sandbox environment by embedding the blockchain smart contract., On the other hand, should establish a "central-local-market" three-level risk slow-release system: the central government set up special risk compensation fund cover systemic risk, the provincial government set up fiscal funds and financial institutions risk sharing pool, at the same time the introduction of commercial insurance institutions to develop "digital pratt & whitney financial performance guarantee insurance", through the risk pricing model of agricultural financial products precision underwriting and loss sharing, form the combination of prudential supervision and marketization risk management of innovation.

4.2. Dimension of market innovation: Cultivating new business forms and new models of digital finance

1) Build the integrated ecology of "digital technology + scene finance"

In the field of agricultural credit, through the deployment of "satellite remote sensing + drone inspection + AI modeling" star to collaborative monitoring system, build empty three-dimensional credit model, such as big agricultural cooperation with give him bank intelligent agriculture system has realized land moisture real-time analysis, make agricultural loan approval cycle shorten 70% at the same time, the risk of bad debt rate pressure down to 1.2%. In the industrial chain dimension, should develop "industrial Internet + block chain books" supply chain financial solutions, spell of "farmland cloud spell" platform through the iot equipment direct production base, block chain traceability logistics warehousing, intelligent contract automatic clear money, build up "field to table" digital production closed loop, the model not only realize the agricultural uplink scale 300% growth, more make small and medium-sized farmers financing costs fell by 45%, form technology can assign and scene of virtuous cycle. By simultaneously promoting the innovation of intelligent evaluation system and the upgrading of industrial chain financial services, the construction of the deep integration ecology of "digital technology + scene finance" is realized.

2) Innovate the comprehensive service mode of "finance + non-finance"

In order to realize the deep integration of financial services and industrial ecology, we should build a three-dimensional service matrix of "financial empowerment + ecological co-construction". In service mode innovation level, can integrate banking institutions, electric business platform and agricultural service organization resources, build "financing credit-agricultural technology support-market docking" full link service package, such as jingdong financial joint cooperatives launched "Beijing is borrowed", through order agricultural data cross validation, not only the loan interest rates down 2-3%, more drive farmers product premium sales more than 20%. In value extension dimension, innovative green financial tools, build covers carbon footprint accounting, carbon sink asset pricing "agricultural carbon account" system, Fujian Sanming will forestry carbon sink into can pledge of carbon assets, relying on block chain technology to realize carbon sink approval, valuation, circulation of the whole process of digital, has moved green credit of 520 million yuan, created the ecological value to financial value of sustainable path.

4.3. Dimension of capacity building: cultivating new quality and productive entities of digital finance

1) Implement the "New Rural Farmer Digital Financial Literacy Improvement Project"

The implementation of the "New Farmer Digital Financial Literacy Improvement Project" is the key to solve the "last kilometer" problem of rural finance, and it is necessary to build a two-wheel driving mechanism of "training system + service

sinking". On the one hand, should rely on the county digital financial institute build immersive training scenarios, using AR virtual credit approval, VR agricultural technology operation simulation digital teaching tools, cultivating family farms, co-operatives and other new operators, Anhui Jin Zhai through "holographic digital agricultural school" to carry out interactive teaching, make participation subject digital tool utilization rate jumped from 32% to 89%, On the other hand, need to implement "1 + 1" financial village official system, for each administrative villages equipped with financial qualification of residency consultant, synchronous deployment of intelligent voice customer service, block chain contract parsing AI assistant, form "artificial guidance daily consulting + intelligent matching credit products" the closed loop service, the model in Zhejiang Lishui pilot administrative villages digital financial services 100% coverage, effectively eliminate the "digital divide", activate the endogenous power of rural financial ecology.

2) Build a "industry-university-research-application" collaborative innovation system

The construction of "industry-university-research-application" collaborative innovation system is the key path to break the "research and development island" and "application fault" of rural fintech, and it needs to realize the innovation closed loop through the two-wheel drive of technological breakthrough and achievement transformation. In technology research and development dimension, should be formed by the head top financial institutions joint digital pratt & whitney financial joint laboratory, key breakthrough edge computing intelligent terminal, multiple security technology, industrial and commercial bank through "5G wisdom network" laboratory has been successfully developed offline face recognition, satellite communication encryption 47 patent technology, effectively solve the problem of rural network calculate power restriction. In achievement transformation level, need to establish a "innovation works research + industry accelerator promotion" relay mechanism, such as China construction bank in shaanxi wugong county structures "kiwi fruit industry chain digital financial sandbox", the laboratory block chain traceability technology into orchard approval, cold chain monitoring 12 application modules, make the supply chain financing coverage increased by 60%, form a "technical research-scenario-scale replication" spiral of innovation ecology.

4.4.Dimension of institutional guarantee: to improve the long-term development mechanism

1) Establish a dynamic monitoring system for the digital divide between urban and rural areas

The establishment of the dynamic monitoring system between urban and rural areas is the strategic fulcrum to promote the precise implementation of inclusive finance, and it is necessary to build a full-cycle governance mechanism of "data monitoring-index evaluation-policy intervention". Through the integration of mobile payment permeability, digital credit availability of 12 dimensions of 36 core

indicators, build county digital financial development dynamic heat map, accurate positioning of the Midwest poverty region financial services "digital blind area", such as relying on operator base station signal heat map superposition bank service network coordinates, realize administrative villages digital service vacuum real-time early warning. Synchronous to establish "digital pratt & whitney financial development index" annual white paper release system, the regional score and fiscal transfer payments, financial regulatory policy, for three consecutive years index growth below 30% of the national average county, automatic trigger "digital infrastructure compensation package" delivery mechanism, through directional increase 5G base station construction special debt lines, intelligent terminal purchase subsidies implement precision intervention, form "monitoring-evaluation-compensation" closed-loop governance system.

2) Optimize policies for fiscal and financial support

Optimizing the policy of fiscal and financial coordination and support is the institutional guarantee to solve the "market failure" and "lack of innovation momentum" of county digital finance, and it is necessary to build a policy combination of "incentive compatibility + risk sharing". In view of the high cost of digital financial innovation in the county level, a special fund for the development of new quality productivity should be set up, and a certain amount of additional deduction policy should be implemented for R & D investment such as blockchain credit system and intelligent risk control model.

5. Conclusion and outlook

By constructing a three-dimensional evaluation system of digital inclusive finance, new quality productivity and urban-rural integration development, based on the provincial panel data of 2015-2022, the study systematically reveals the role mechanism of digital inclusive finance to promote urban-rural integration through new quality productivity intermediary, and puts forward optimization strategies according to the practical difficulties. The main conclusions show that: first, digital inclusive finance has a significant positive role in promoting urban-rural integrated development ($\beta = 0.427$), which directly promotes the urban-rural economy by expanding the coverage of financial services (weighting 0.213) and optimizing the allocation efficiency of agricultural resources (capital mismatch rate reduced by 12.6%); second, the intermediary effect of 38.6% in the transmission path, of which technology penetration is the core driving force; however, the research has not fully quantified the regulation effect of digital divide, and limited by macro statistics, and fails to reveal the behavioral feedback mechanism of micro subjects. Future research can further integrate multi-source heterogeneous data, build a "macro-medium-micro" cross-level analysis framework, strengthen the comparative research with practice cases in developing countries, and explore the

universal law of urban-rural integration enabled by digital economy.

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