Exploration of the Coupled Coordination Relationship between Digital Inclusive Finance and New Urbanization

Shixin Jiang*, Qian Yu, Yidong Qin

School of Economics, Wuhan University of Technology, Wuhan, China

*Corresponding author: h2017jsx@163.com

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Abstract: New urbanization, a pivotal strategy for national modernization, is intricately linked to the development of digital inclusive finance. This study aims to investigate the coupled coordination relationship and regional disparities between digital inclusive finance and new urbanization. By establishing an evaluation index system for new urbanization, this paper assesses the development levels of 267 Chinese cities from 2011 to 2021 using the entropy-weighted TOPSIS method, and explores their interaction through a coupling degree and coordinated development model. The findings reveal an overall upward trend in the coordination degree, with the eastern region significantly outpacing other areas. Policy recommendations suggest enhancing regional collaboration, adopting tailored policies, and leveraging the dual roles of the market and government to foster balanced growth between digital inclusive finance and new urbanization.

1. Introduction

Digital inclusive finance is pivotal in reducing financing costs for businesses and supporting real economy development, integral to national strategy execution. Concurrently, new urbanization is vital for national modernization, offering a conducive environment for digital finance growth. This urbanization strategy, crucial in modern China, provides a platform for the digital finance sector, emphasizing the need for efficient resource allocation, especially in rural areas, to bridge the urban-rural divide.[1] Small and medium-sized enterprises (SMEs), facing funding challenges, are essential for urbanization progress, necessitating improved financial services.

Furthermore, digital finance development underpins new urbanization by enhancing financial efficiency, supporting enterprise innovation, and promoting industrial upgrades towards a greener economy. Leveraging digital technology, it offers an alternative to traditional financing methods, reducing costs and improving access for SMEs.[2] This financial inclusivity boosts consumer credit, lowers transaction costs, and fosters high-quality economic growth. It also expands consumption in rural areas, aiding in narrowing urban-rural disparities. Nonetheless, the influence of digital finance on the urban-rural income gap demonstrates a transitional phase, initially widening before gradually narrowing.[3]

2. Constructing a Model for the Coupled Coordination Development between Digital Inclusive Finance and New Urbanization

The evaluation system for new urbanization, as a comprehensive index system encompassing multiple indicators and dimensions, necessitates the adoption of a multi-indicator comprehensive evaluation method to amalgamate various indicators into a singular index for examination.[4] The synthesis of these indicators into a composite index reflecting the development level of new urbanization primarily involves the weighting of each indicator, followed by the application of a weighted function method to obtain the indices for each subsystem and the comprehensive index of new urbanization development.[5] Following a comparative analysis of the literature review, this paper employs the entropy-weighted TOPSIS method for weighting and computation, offering a more

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exhaustive consideration of the roles of various subsystems within new urbanization. The specific steps include:

(1) Standardization process. Given the diverse units and dimensions of the collected indicator data, it is imperative to standardize these indicators. The formulae for this process are as follows:

$$X_{ij}=\begin{cases}\left(\alpha_{ij}-\min\left(\alpha_{ij}\right)\right)/\left(\max\left(\alpha_{ij}\right)-\min\left(\alpha_{ij}\right)\right), & x_{ij}\ \textit{is positive indicators}\\ \left(\max\left(\alpha_{ij}\right)-\alpha_{ij}\right)/\left(\max\left(\alpha_{ij}\right)-\min\left(\alpha_{ij}\right)\right), & x_{ij}\ \textit{is negative indicators}\end{cases} \tag{1}$$

Here, α_{ij} represents the original data value; X_{ij} denotes the standardized value of the jth indicator for the ith system, ensuring that after standardization, all X_{ij} indicator values are confined within a predefined range.

(2) Weighting. Objective weighting is assigned to the standardized indicators as follows:

$$w_j=\frac{1-H_j}{m-\sum_{j=1}^{m}H_j} \tag{2}$$

where $H_j=-k\sum_{j=1}^{n}f_{ij}\ln f_{ij}$, $f_{ij}=\frac{X_{ij}}{\sum_{j=1}^{n}X_{ij}}$, $k=\frac{1}{\ln n}$, and H_j is the entropy of the jth indicator.

(3) Calculation of the Relative Closeness Coefficient. This involves several steps: first, constructing a weighted decision matrix; second, identifying the positive and negative ideal solutions; third, calculating the Euclidean distance to these ideal solutions; and fourth, calculating the relative closeness coefficient. The formulae for this process are as follows:

$$R=(r_{ij})_{mn}=(w_j\times X_{ij})_{mn} \tag{3}$$

$$\begin{aligned}R^{+}&=\max(r_{1j},r_{2j}...r_{ij})\\ R^{-}&=\min(r_{1j},r_{2j}...r_{ij})\end{aligned} \tag{4}$$

$$\begin{aligned}D_i^{+}&=\sqrt{\sum_{j=1}^{n}(r_{ij}-R_j^{+})^2}\\ D_i^{-}&=\sqrt{\sum_{j=1}^{n}(r_{ij}-R_j^{-})^2}\end{aligned} \tag{5}$$

$$C_i=\frac{D_i^{-}}{D_i^{+}+D_i^{-}} \tag{6}$$

Given that data for the Digital Inclusive Finance Index can be directly obtained and its range exceeds 0−1, this index is also standardized before applying the subsequent model.

This article delineates the coupling and coordination between digital inclusive finance and new urbanization into three intervals and seven stages.

Table 2 presents the calculated results of coupling coordination degrees, evaluating the level of coordinated development between digital inclusive finance and new urbanization, in reference to the classification in Table 1. Overall, the stages of coordinated development have evolved from severe disequilibrium in 2011 through moderate disequilibrium during 2012-2015, slight disequilibrium during 2016-2019, to mild coordination during 2020-2021. This indicates that the coupling coordination between digital inclusive finance and new urbanization is still in a period of adjustment, having entered the stage of mild coordination within the marginally acceptable range. Overall, the coupling coordination degree improved from 0.212 in 2011 to 0.430 in 2021, advancing from

moderate disequilibrium to the stage of mild coordination. Regional analysis shows a "high in the East, low in the West" pattern. In the Eastern region, the coupling coordination degree increased from 0.239 in 2011 to 0.464 in 2021, advancing from moderate disequilibrium to mild coordination. The level of coupling coordination development in the Eastern region has consistently been above the overall level, with relatively stable development. In the Central region, the degree improved from 0.200 in 2011 to 0.422 in 2021, advancing from moderate disequilibrium to mild coordination. The level of coupling and coordination development in the Central region has been consistently below the overall level, though the gap has gradually narrowed. In the Western region, the degree increased from 0.194 in 2011 to 0.406 in 2021, evolving from severe disequilibrium to mild coordination, remaining below the overall level throughout the period. In the Northeastern region, the degree improved from 0.213 in 2011 to 0.424 in 2021, moving from moderate disequilibrium to mild coordination. The level of coupling coordination development in the Northeastern region was above the overall level from 2011 to 2014 but fell below the overall level starting in 2015.

Table 1. Classification of Coupling Coordination Stages

Coupling Coordination Degree	Stage of Coupling Coordination	Interval of Acceptability
$0.8 < D \leq 1$	Optimal Coordination	Acceptable Range
$0.6 < D \leq 0.8$	High Coordination	
$0.5 < D \leq 0.6$	Moderate Coordination	
$0.4 < D \leq 0.5$	Mild Coordination	Marginally Acceptable Range
$0.3 < D \leq 0.4$	Slight Disequilibrium	
$0.2 < D \leq 0.3$	Moderate Disequilibrium	Unacceptable Range
$0.0 < D \leq 0.2$	Severe Disequilibrium	

Table 2. Coupling Coordination Degrees of Digital Inclusive Finance Construction and New Urbanization, 2011-2021

Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Overall	0.212	0.261	0.292	0.304	0.324	0.342	0.353	0.358	0.368	0.416	0.430
Eastern	0.239	0.283	0.315	0.324	0.343	0.362	0.372	0.379	0.388	0.435	0.464
Central	0.200	0.251	0.283	0.294	0.318	0.331	0.343	0.346	0.361	0.416	0.422
Western	0.194	0.246	0.278	0.291	0.310	0.333	0.346	0.350	0.357	0.399	0.406
Northeastern	0.213	0.263	0.292	0.306	0.321	0.339	0.345	0.350	0.360	0.407	0.424

3. Analysis of the Driving Factors for the Coordinated Development of Digital Inclusive Finance and New Urbanization

3.1 Selection of Variables and Model Construction

The coordinated development of digital inclusive finance and new urbanization is a systemic project that necessitates leveraging the decisive role of the market in resource allocation, fully utilizing government's promotive role, and actively involving corporations and the public. Drawing on relevant research findings, this study selects coupling coordination degree as the dependent variable, and investment preference, economic density, economic distance, financial efficiency, government intervention, and education level as explanatory variables for analysis. These explanatory variables are categorized into economic geographical factors, new economic geographical factors, and economic policy factors. Utilizing panel data from 267 cities across 30 provinces from 2011 to 2021, a econometric model for the driving factors of coupling and coordination development is established as follows:

$$DD_{it} = \alpha + \beta_1 Inv_{it} + \beta_2 Den_{it} + \beta_3 Dis_{it} + \beta_4 Fin_{it} + \beta_5 Gov_{it} + \beta_6 Edu_{it} + \eta_i + \rho_t + \varepsilon_{it} \quad (7)$$

where DD represent the degree of coupling and coordination development, which serves as the dependent variable in our model. The independent variables are Inv symbolizing investment

preference, Den representing economic density, Dis indicating economic distance, Fin for financial efficiency, Gov denoting government intervention, and Edu for education level.

3.2 Full Sample Regression Analysis

The regression results in Table 3 indicate that investment preference, economic density, economic distance, and education level are all significant at the 1% level, while financial efficiency and government intervention are significant at the 10% level. This suggests that enhancing urban investment, creating a favorable financial environment, formulating appropriate development policies, and improving local education levels can inject strong momentum into the development of the coupling coordination degree. On the other hand, although all the dynamic factors contribute to the coordinated development of digital inclusive finance and new urbanization, the extent of their impact varies considerably, particularly in the case of economic density and education level. In conclusion, the dynamic development of coupling coordination is pronounced, with the main driving factors currently being new economic geographic factors, while there remains significant room for growth in traditional economic geographical factors and economic policy factors.

Table 3. Regression Results of Dynamic Factors Influencing Coupling Coordination Development

Variable	Full Sample		Regional Breakdown			
	Fixed Effects	Random Effects	Eastern	Central	Western	Northeastern
Investment Preference	0.0531***	0.0898***		0.0565	0.00255	0.0365
Economic Density	2.46e-06***	2.30e-06***		3.69e-06***	7.92e-07	1.85e-06
Economic Distance	0.293***	0.0226***		0.244***	0.209***	0.315***
Financial Efficiency	0.0982*	0.112**		0.0466	0.331***	0.139***
Government Intervention	0.0722*	0.0608**		0.412***	-0.0906*	0.105
Education Level	0.000339***	0.000330***		0.194	0.000333***	-0.00251
Constant	-0.118***	0.154***		-0.174**	-0.190***	-0.0858*
N	2,937	2,937		902	847	858
R2	0.360	/		0.319	0.594	0.415
Number of Cities	267	267		82	77	78

Based on differing levels of economic development, the sample is divided into four regions: Eastern, Central, Western, and Northeastern, for a heterogeneity analysis. The regression structure of subsamples in Table 3 reveals that in the Eastern region, the primary driving factors are new economic geography factors (economic density, economic distance) and some economic policy factors (government intervention), with regression coefficients of 3.69e-06, 0.244, and 0.412 respectively, all passing the 1% significance test, while other dynamic factors show a non-significant positive influence. This may be because the Eastern region, as the leading area of China's opening up, has prioritized interconnected transportation infrastructure, attracted significant capital and technology through its distinct locational advantages, and the financial institutions such as banks in the region have a denser network compared to other regions, which facilitates the efficient, low-cost circulation of production factors. In summary, all economic regions exhibit issues with insufficient dynamic development, with clear differences in regional dynamics, which significantly affect the level of coupling coordination development between digital inclusive finance and new urbanization. The Central and Eastern regions display a diversity of developmental dynamics, while the Western and Northeastern regions show a more singular developmental force.

4. Conclusion

The principal findings of this study demonstrate an overall increase in the coupling coordination

degree between digital inclusive finance and new urbanization from 2011 to 2021, revealing significant regional disparities. These insights offer a novel perspective for understanding how to advance national modernization by fostering the coordinated development of digital financial inclusivity and the urbanization process. Particularly, the leading position of the Eastern region underscores the necessity for regional collaboration and differentiated policies to promote balanced growth. The research also elucidates the roles of economic geographic factors, new economic geographic factors, and economic policy factors in driving the coordinated development, providing a foundation for practical enhancements of the coordination level between the two. Future research could further explore the roles of other potential factors and how technological innovation can facilitate this process. In conclusion, this study not only contributes new knowledge to the relevant fields but also provides practical guidance for policymakers, emphasizing the importance of the dual role of markets and government in promoting the coordinated development of digital inclusive finance and new urbanization.

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