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The Empirical Study of Digital Inclusive Finance on Rural Green Economy Development

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Abstract: This article discusses the role that inclusive digital finance plays in rural green development against the backdrop of rural revitalization strategies. The results demonstrated that the growth of the rural green economy has been significantly aided by the digital inclusive finance, and that this impact has significant regional heterogeneity, with the impact on the eastern and western regions being noticeably stronger than that on the central and northeastern regions. This study contributes to the current of empirical research on the connection between rural green construction and inclusive digital finance. Finally, relevant suggestions are put forward to help promote the green growth of agriculture and rural areas and realize the strategy of rural revitalization.

Keywords: digital inclusive finance, rural green economy, fixed utility model.

1. Introduction

The world community has expressed great concern about green growth as a model for sustainable development.Under the guidance of the “carbon peaking and carbon neutrality” policy, the rural green development has attracted more attention. Agriculture is the pillar of rural economy, and agricultural activities are an important source of global greenhouse gas emissions. Due to the dual characteristics of carbon sources and carbon sinks, agricultural ecosystems have also become the focus of attention. How to upgrade rural industry and support the green growth of rural regions under the guidance of rural revitalization policy is also a subject that deserves study. Digital technology and the Internet have made it possible for rural areas to access equal financial services, which has helped to advance the green development of rural. Furthermore, the use of digital inclusive finance has emerged in the development of green small and micro enterprises, efficient ecological agriculture, rural construction, and other fields. However, most of the papers on this issue tend to theoretical discussion and need to do further analysis and empirical research on the basis of theoretical research. This paper examines the role of digital inclusive finance in rural green development from the standpoint of green development and helps to better develop digital inclusive finance, settle the problems of rural green development and promote rural green development.

2. Literature review

“Inclusive Finance” is intended to solve the problem of the widening global wealth gap and the gradual imbalance of financial resource allocation. Numerous studies have shown that inclusive finance has played a positive role in alleviating these problems. Existing research shows that a lot of

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population groups are excluded from the service of formal financial institutions, while inclusive finance effectively increases the capital availability of the poor population, to achieve poverty alleviation and income increase [1-3]. According to research from the perspectives of financial development and economic development, inclusive finance improves the financial system while reflecting financial equity, assisting in the eradication of poverty, and increasing domestic demand—all of which are crucial for sustainable development [4-5]. Digital inclusive finance makes financial services better serve low-income and vulnerable groups, to reflect the correct ' inclusive consciousness ' and the new possibility of inclusive finance.Internet and other information technologies have enhanced the service availability and accessibility of inclusive finance and improved the credit reporting system by mining user data.In space to break through the traditional financial time and space constraints, greatly improving the utilization of resources[6-8].With the improvement of the economic level, agricultural production conditions have been improved, but extensive development has brought serious pollution problems. 80 % of the world's rural livelihoods are directly related to agriculture [9]. However, the increasing production has caused great pressure on the ecological environment, which needs more attention in the green development strategy [10-11]. The concept of green development is a sustainable development model that takes into account economic benefits and ecological environment capacity [12].Green agriculture requires agricultural development to reduce the damage to the environment and biodiversity. To China's agricultural problems, it is necessary to carry out agricultural green transformation from the perspective of ecological civilization [13-14].Many scholars ’ studies have shown that the green development of agricultural and rural areas needs to strengthen planning research, promote agricultural modernization and industrialization, strengthen infrastructure construction, vigorously develop agricultural tourism, pay attention to agricultural innovation and branding, and form market mechanisms [15-16].

Experts think that by increasing the effectiveness of agricultural fund allocation and distributing risks, digital inclusive finance improves rural economic development [17]. The concept of green development is supported by digital inclusive finance, which also encourages the flow of resources to emerging environmental protection industries like ecological agriculture, circular agriculture, intelligent agriculture, creative agriculture, and others. This significantly supports the green development of agriculture [18-19]. But the current digital inclusive finance still falls short of a reliable credit system and related policies and regulations, necessitating in-depth research to help advance digital inclusive finance's function [20-21].

3. Theoretical Analysis and Research Hypothesis

The development of digital inclusive finance has solved the problems of “commercial sustainability” and “cost affordability” in traditional inclusive finance. It breaks geographical restrictions, and Internet technology has changed the financial service mode. It does not need to set up a network of customers in remote areas, and can also easily obtain financial services, saving customers ' time and transportation costs, and the labor and construction costs of financial institutions. Moreover,digital inclusive finance uses big data to collect large amounts of consumption and credit data and establish a customer information base, which greatly alleviates the problem of information asymmetry in financial institutions. Financial resources can serve agriculture and rural areas more efficiently and promote rural economic and industrial development.Additionally, digital inclusive finance may provide financial resources into the field of low carbon and green field, and support the green growth of the rural economy when guided by green development policies like “ carbon peaking and carbon neutrality”.

Based on the analysis presented above, this study puts forth Hypothesis 1: digital inclusive finance promotes the growth of the rural green economy.

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China is a country with vast territory. The development of digital inclusive finance varies from region to region.In regions with more mature financial markets, the restriction of resource flow will be greatly reduced. Market competition makes the allocation of financial resources more efficient, forms a fair distribution mechanism, and vulnerable groups have more opportunities to obtain financial services. At the same time, there are significant spatial differences in resource endowments and ecological environments in rural areas. In areas with rich resources, perfect industrial structure, and technological progress, the rural green economy develops better. In regions with extensive economic development, environmental problems will be more prominent.

Based on the analysis presented above, this study puts forth Hypothesis 2: the influence of digital inclusive finance on the rural green economy varies significantly by region.

4. Indicator Selection and Empirical Research

4.1. Measurement of Rural Green Economy

Due to different research focuses, a standardized indicator system of rural green development level has not been formed.According to the strategic planning of rural revitalization, some scholars have studied from five dimensions : industrial prosperity, ecological livability, rural civilization, effective governance and rich life.Through regional differences and dynamic evolution analysis, the specific situation of rural revitalization and development in various provinces and cities in China is obtained[22].Considering the characteristics of rural development and highlighting the research focus on rural green economy, this paper selects the measurement index system of rural revitalization and development level in China constructed by Xue Longfei as the indicator of rural green development. As shown in Table 1.

Table 1: Rural green economy index system.

first grade indexes	second grade indexes	unit	Indicator direction
industrial prosperity	The gross output value of agriculture, forestry, animal husbandry, and fishery/rural population	(Yuan/person)	+
	Farmland area/rural population	(%)	+
	The proportion of agricultural, forestry and water affairs expenditure in general fiscal expenditure	(%)	+
	The percentage of added value of primary industry in regional GDP	(%)	+
	Per capita added value of agriculture, forestry, animal husbandry, and fishery	(1000 hm^2) (10000 KW·h/1000 hm^2)	+ +
ecological livability	Water-saving irrigation area	(%)	+
	Total power of agricultural machinery	(%)	+
	Forest area/land area		
	Cumulative number of		

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rural civilization	sanitary toilets/total number of rural households	(10000 t/1000 hm^2)	-
	Fertilizer use/arable land	(%)	+
	The proportion of administrative villages with centralized water supply	(rural=1)	-
	Urban and rural landscaping coverage area/rural landscaping coverage area	(%)	+
	Environmental pollution control investment / GDP	--	+
	Number of township cultural stations	-- (rural=1)	+
	Number of pension institutions	(%)	-
effective governance	Comparison of Years of Education between Urban and Rural Residents	(%)	+
	Population Coverage Rate of Radio Programs	(%)	+
	TV program population coverage rate	(rural=1)	+
	Per capita expenditure on rural cultural and educational entertainment/per capita consumption of rural residents	(rural =1) (rural=1)	- -
rich life	Urban per capita income / rural per capita income	(%)	-
	Urban total dependency ratio/rural total dependency ratio	(%)	+
	Urban residents ' health expenditure/rural residents ' health expenditure	(%)	+
	Total number of administrative villages / administrative villages dealing with domestic sewage	(yuan / person) (rural=1) (rural=1)	- + -
	Total number of administrative villages / administrative villages dealing with domestic waste	(%)	-
	Crop disaster area / arable land	(ten	+
	Farmers' disposable income	thousand)*Proport	

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	Urban per capita consumption/rural per capita consumption	ion of rural population(%) (rural=1)	+
	Engel coefficient of urban residents/Engel coefficient of rural residents	(%)	-
	Rural residents' health care expenditure/rural residents' consumption expenditure		+
	Internet broadband access ports		
	Number of health technicians per thousand urban population / rural population		
	Administrative villages with clinics/Total number of village		

Given the serious lack of data in Tibet and the lack of comparable general characteristics in Hong Kong, Macao, Taiwan, and other regions, Xue Longfei selected 30 provinces and cities in China except for the above four provinces as the research objects in the index construction, collected the relevant data from 2011 to 2018 as the original data, and selected the entropy weight method to give weight to each index. As an objective weighting method, the weighting method can avoid human subjectivity and be more scientific and objective.

4.2. Empirical study

4.2.1. Variable description and data sources

Explained variable : rural green economy level (GE), replaced by the rural green economy index, indicating the rural green economy level of 30 provinces in China.

Explanatory variable: Digital Inclusive Finance Index (DIFI), which adopts the " Digital Inclusive Finance Index of Peking University (2011 – 2020) " released by Peking University.

The relevant control variables as follows: urbanization rate (urban), which is expressed by the percentage of the urban population in the total population. The level of rural infrastructure construction is expressed by rural electricity consumption(construction). Industrial structure adjustment (industry), this paper selects the ratio of the second and third industries added value and the first industry added value to measure. Educational level (education) is measured by the percentage of college students in the population at the end of the year. Control variables data mainly collected from "China Agricultural Statistics Yearbook " and EPS database.

4.2.2. Model setting and research methodology

This paper chooses the fixed effect model for empirical research. The rural green economy development index adopts the percentage. The model is as follows :

$$lnGE_{it} = c + \alpha_1 lnDIFI_{it} + \alpha_2 lnX_{it} + \varepsilon_{it} \quad (1)$$

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$lnGE_{it}$ is the explained variable, delegating the development level of the rural green economy in t-year i province,$lnDIFI_{it}$ is the explanatory variable, representing the digital inclusive financial index in t-year i province, lnX_{it} is a series of control variables, representing random disturbance items.

4.2.3. Experimental results and analysis

Descriptive statistics. Table 2 is descriptive statistics of variables. In the overall sample data, the gap between the maximum and minimum values of rural infrastructure construction level and industrial structure is large, indicating that there is a large gap between regions.

Table 2: Descriptive statistics.

variable	N	mean	p50	sd	min	max
$lnGE_{it}$	240	3.513	3.517	0.305	2.468	4.209
$lnDIFI_{it}$	240	5.073	5.319	0.669	2.936	5.879
$lnurb_{it}$	240	4.035	4.021	0.205	3.599	4.492
$lncon_{it}$	240	4.838	4.652	1.333	1.504	7.533
$lnind_{it}$	240	2.462	2.279	0.943	1.150	5.547
$lnedu_{it}$	240	0.621	0.614	0.257	-0.132	1.204

Benchmark regression. Regression results in Table 3 show that the core explanatory variable positively impacts the rural green economy at 1% statistical level. Hypothesis 1 is valid. For every unit increase in core explanatory variable , the development level of the rural green economy increases by 0.071 units. With regard to the control variables,the urbanization rate positively affects the rural green economy,which is obvious at the 1 % statistical level. With the continuous aggregation of the population to cities, the urbanization rate continues to increase, agricultural activities are gradually transformed into non-agricultural activities, and the revenue of rural residents are gradually changing. The regression result of rural infrastructure construction shows that the growth of rural electricity consumption has a certain role in promoting rural green development. However, the relationship between the two is not obvious. It may be that rural infrastructure needs other industries to work together. For each unit increase in the industrial structure, the rural green economy increases by 0.111 units.It shows that the rural economy should be based on the transformation of industrial structure and realize the transition of processed products from the low economic added value to high economic added value through industrial upgrading to realize rural economic growth.For every unit increase in education level, the rural green economy will increase by 0.226 units. A significant aspect in determining long-term economic growth is human capital. The degree of agricultural technology will be greatly raised with increased education, which will enhance product returns and raise farmer revenue.

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Table 3: Benchmark regression.

	(1)
VARIABLES	$lnGE_{it}$
$lnDIFI_{it}$	0.071***
	(0.012)
$lnurb_{it}$	0.743***
	(0.165)
$lncon_{it}$	0.012
	(0.025)
$lnind_{it}$	0.111***
	(0.039)
$lnedu_{it}$	0.226**
	(0.105)
_cons	-0.315
	(0.575)
N	240
r2	0.802
r2_a	0.770

Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01(the same below).

Endogenous discussion. Considering the missing variables and bidirectional causality, to solve the endogeneity problem, this paper uses two-stage least squares estimation to correct the endogeneity problem of the model. Information transmission, software, and information technology service industry investment are selected as instrumental variables. As shown in Table 4, in the empirical test of the two-stage least squares estimation, the F value in the first stage is greater than 10, passed the weak instrumental variable test. The second stage regression results show that after considering the endogenous problem, digital inclusive finance still impacts the rural green economy, which declares that the above benchmark regression results are robust and consistent.

Table 4: Endogenous test: two-stage least squares method.

	(1)	(2)
	first	second
VARIABLES	$lnDIFI_{it}$	$lnGE_{it}$
$lnDIFI_{it}$		0.396***
		(7.17)
$lnurb_{it}$	1.108***	-0.451**
	(3.11)	(-2.38)
$lncon_{it}$	-0.120***	0.153***
	(-3.57)	(12.88)
$lnind_{it}$	-0.068	-0.027
	(-1.00)	(-0.85)
$lnedu_{it}$	-0.113	0.063
	(-0.65)	(0.84)
$lngjbl_{it}$	0.448***	
	(7.98)	
Constant	-0.699	2.610***
	(-0.58)	(4.78)
F value	F(5，234) = 32.35	
Observations	240	240
R-squared	0.409	0.432

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t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Heterogeneity test. In order to examine heterogeneity, this paper divides 30 provinces into eastern, western, central, and northeastern regions according to the division of the China Statistical Yearbook, and tests them according to the established model.The eastern region has the superior geographical location and developed economy. Rural green development has been supported by material and technical support. So digital inclusive finance can promote rural green economy.The result in the western region shows that the policy support of poverty alleviation in the western region has improved the poverty situation in rural areas and promoted green development (Wang , 2021). The central and northeastern regions did not pass the test. The heterogeneity test shows hypothesis 2 is valid.

Table 5: Heterogeneity test.

	Eastern part	Western part
VARIABLES	$lnGE_{it}$	$lnGE_{it}$
$lnDIF_{it}$	0.138***	0.034**
	(0.031)	(0.013)
$lnurb_{it}$	0.266	1.070***
	(0.350)	(0.179)
$lncon_{it}$	-0.075**	0.148**
	(0.035)	(0.069)
$lnind_{it}$	0.224***	-0.036
	(0.069)	(0.072)
$lnedu_{it}$	0.047	0.155
	(0.329)	(0.117)
_cons	1.491	-1.594***
	(1.303)	(0.595)
N	80	88
r2	0.729	0.930
r2_a	0.671	0.915

5. Conclusion and enlightenment

This article empirically evaluates the impress of digital inclusive finance on the rural green economy using panel data from 30 provinces and cities. The findings indicate that: (1) The rural green economy can be considerably aided by the use of digital inclusive finance. The assistance of funding and policies is essential to the development of rural areas. Rural areas should give more consideration to green and efficient development by the policy directives of rural revitalization and "carbon peaking and carbon neutrality". The adoption of inclusive finance policies for the digital age encourages the flow of money to rural areas' green innovation sectors and realizes the green growth of rural areas. (2) There is clear geographical variability in how digital inclusive financing affects the rural green economy. There is significant geographic variability in how digital inclusive financing impacts the rural green economy, mainly due to the distinction in economic development and resource policies between different regions.

Based on the existing research and empirical analysis of this paper, the following suggestions are put forward :

(1) Local governments should accelerate the construction of digital inclusive finance, ease data barriers, and speed up the construction of “digital villages”. Technology enterprises and financial institutions are encouraged to cooperate in-depth, build agriculture-related basic data platforms and

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rural credit system construction, and integrate information such as green environmental protection into information-sharing platform to improve service efficiency and promote the flow of financial resources to more green areas [23].

(2) Digital inclusive finance needs to further use big data to analyze financial needs in the process of agricultural development, formulate corresponding policies, and increase support for agriculture. Through the targeted reduction of digital inclusive finance, policy financing guarantee, and improving the discount rate of agricultural support, the credit quota of residents in rural areas is improved, and the financing difficulty and financing cost of poor farmers are effectively solved, so that more vulnerable groups can get fair financial services [24].

(3) The government should focus on the imbalance of rural development in China so that high-level green development areas play a leading act in radiation. To narrow the regional gap and promote the coordinated progress of digital inclusive finance among regions, the central and northeastern regions need to be concerned about promoting the flow of resource elements among regions. Further analysis of the transmission mechanism of digital inclusive finance is needed to inject vitality into the rural green economy [25].

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