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THE IMPACT OF RURAL INCLUSIVE FINANCE ON FOOD SECURITY IN CHINA

O IMPACTO DO FINANCIAMENTO RURAL INCLUSIVO NA SEGURANÇA ALIMENTAR NA CHINA

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ABSTRACT

Hunger breeds discontentment. Inclusive finance is an effective way to achieve national food security. Based on relevant literature, this article constructs a comprehensive index of inclusive finance that only targets rural development. Utilizing the GMM model, this study explores the impact of rural inclusive finance on food security in China, based on panel data from 30 provinces, autonomous regions, and municipalities directly under the Central Government from 2011 to 2020. The findings indicate a significant positive effect of rural inclusive finance on food security. Heterogeneity analysis reveals regional disparities in the impact of rural inclusive finance on food security. Therefore, relevant departments should strengthen the construction of digital agricultural infrastructure, foster a favorable environment for rural inclusive finance, enhance the financial literacy of rural households, and further improve food security.

Keywords: Rural inclusive finance; Food security; GMM; China.

RESUMO

A fome gera descontentamento. O financiamento inclusivo é uma forma eficaz de alcançar a segurança alimentar nacional. Com base na literatura relevante, este artigo constrói um índice abrangente de financiamento inclusivo que visa apenas o desenvolvimento rural. Utilizando o modelo GMM, este estudo explora o impacto do financiamento rural inclusivo na segurança alimentar na China, com base em dados de painel de 30 províncias, regiões autónomas e municípios diretamente subordinados ao Governo Central, de 2011 a 2020. Os resultados indicam um efeito positivo significativo. do financiamento rural inclusivo na segurança alimentar. A análise da heterogeneidade revela disparidades regionais no impacto do financiamento rural inclusivo na segurança alimentar. Portanto, os departamentos relevantes devem reforçar a construção de infra-estruturas agrícolas digitais, promover um ambiente favorável ao financiamento rural inclusivo, melhorar a literacia financeira das famílias rurais e melhorar ainda mais a segurança alimentar.

Palavras-chave: Financiamento rural inclusivo; Comida segura; MGM; China

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1 INTRODUCTION

"Food is the most fundamental requirement of the people."(Huang, 2021) Food security has consistently been a pivotal concern regarding the well-being of the nation and the sustenance of its citizens. Food security, as outlined by the Food and Agriculture Organization (FAO), encompasses a state in which every individual enjoys continuous and unrestricted physical, social, and economic access to an ample supply of safe and nourishing food (FAO, 2006).

China's grain output has exhibited a consistent upward trajectory in recent years, reaching a five-year plateau of over 650 billion kilos. This achievement effectively resolves the issue of food sufficiency. Nonetheless, the population's rising demand for high-quality food and the structural imbalance and inadequacy of food supply are gaining prominence (FAO, 2006; Fróna et al., 2019). Food security faces multiple challenges, including significant funding gaps in grain production and supporting infrastructure, reduced arable land, relative scarcity of agricultural resources, substantial impacts of climate change, and upgraded consumption structures(Jiao et al., 2018; Yu et al., 2019; Chen et al., 2019; Masters, 2021; Jayasinghe, 2022; Sun et al., 2023). Furthermore, in contrast to industrialized nations and the global mean, China's approach to resource-intensive agricultural production has remained largely unchanged (J. Huang et al., 2019). In 2019, 325.5 kilograms of agricultural fertilizers were used per hectare, which was 2.6 times the global average and 325.5 kilograms more than the United States; the use of pesticides amounted to 8.7 kilos per hectare, which was 3.3 times the global average (Zhang et al., 2022).

Since 2005, the field of inclusive finance in China has witnessed notable achievements. There has been a substantial increase in the rate of account ownership among residents, as reported by the World Bank and the People's Bank of China in 2020 (Liu, Luan, et al., 2021). China now has the biggest number of unbanked people in the world, at over 225 million, the vast majority of whom are located in rural regions (Zhang et al., 2023). The evolution of rural inclusive finance sheds light on long-standing problems with providing adequate financial backing for food security. The inadequate access to finance could dampen their potentials for growth and competitiveness in the business ecosystem (Lohana, Rashid, Nasuredin, & Kumar, 2019). First, it improves service effectiveness by increasing the breadth of agricultural financial products offered by financial institutions in response to the food market's unique production and trading requirements (Liu et al., 2023). Second, there is a

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structural mismatch in rural finance supply due to the significant uncertainties and hazards connected with food production, as well as a lack of effective collateral among farmers. Using digital technologies such as AI and big data, rural inclusive finance develops formal credit channels for farmers, boosting borrowing through official channels, effectively cutting borrowing costs, eliminating financial exclusion, and improving rural loan accessibility (Lian et al., 2023). Third, it alleviates the suppression of farmers' demands and their reluctance to formal finance, broadens financial service coverage, fulfils food production capital needs, and relaxes financing limitations on both the supply and demand sides, therefore encouraging food production (Balana et al., 2022). Furthermore, rural inclusive finance may intervene in the food production industry chain, accurately support agricultural production demands, boost agricultural firm business revenue, and therefore strengthen food security (Clapp & Isakson, 2018; Huang & Nik Azman, 2023).

Most researchers usually include cities in the scope of research when selecting research areas for inclusive finance to explore the impact of inclusive finance on food security, without focusing on rural areas themselves (Wang L. et al., 2022). In light of this, taking into consideration the specific circumstances in China, this study first establishes an indicator system to measure the comprehensive index of rural inclusive finance and food security in China. Then, based on the panel data of 30 provinces (municipalities and autonomous regions, excluding Hong Kong, Macao, and Taiwan) in China from 2011 to 2020, it employs the System Generalized Method of Moments (SYS-GMM) model to empirically test the impact of rural inclusive finance on food security in China. Finally, it divides food security into four dimensions, analyzes the effects of rural inclusive finance on different dimensions of food security, and conducts regional disparity analysis for different geographical areas and food production functional areas. This approach aims to provide policy recommendations for the national scientific judgment of the path to achieving mid-to-long-term food security strategic goals under the current complex economic form, improve support and protection policies for food production, and ensure China food security.

The remainder of the study is organized as follows: Section 2 summarizes the literature on the relationship between rural inclusive finance and food security. Section 3 constructs the model and presents the data. Section 4 conducts empirical analysis, and Section 5 concludes with corresponding policy implications.

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2. LITERATURE REVIEW

Inclusive finance has been recognized as a key factor in supporting food security in developing countries (Arshad, 2022). Access to financial services and resources enables individuals and households to invest in agricultural activities, enhance productivity, and strengthen food security. This highlights the importance of addressing financial inclusion as a means to mitigate food insecurity (Karki Nepal & Neupane, 2022) . Rural inclusive finance could positively impact food security by improving income and financial opportunities for rural households (Arshad, 2022; Lin et al., 2022).

Several studies have explored the relationship between financial inclusion and food security in rural areas(Lin et al., 2022; Huang & Nik Azman, 2023; Arshad, 2022). Ahmed et al. (2017) conduct a study in rural areas of Pakistan and found that factors such as household size, monthly income, food prices, medical expenses, and debts affect the food security status of rural households. This indicates that improving financial access and income levels through inclusive finance may help strengthen food security. Arshad (2022) examine the impact of financial inclusion on food security in developing countries. The study found that financial development, per capita income, agricultural growth, and education have a positive effect on food security. Huang & Nik Azman (2023) study the impact of digital inclusive finance (DIF) on the operational income of agricultural enterprises in China. Their research revealed that DIF can increase the operational income of these enterprises, thereby enhancing food security. Yu et al. (2021) investigate the relationship between digital inclusive finance and rural consumption in China. They discovered that digital inclusive finance affects rural consumption through income wealth effects, liquidity constraints, and payment methods. This suggests that inclusive finance can directly influence the consumption patterns of rural residents, thereby indirectly affecting food security. Murendo et al. (2021) find that financial inclusion positively affects the nutritional and socio-economic status of rural households in Zimbabwe. Their research shows that financial inclusion increases dietary diversity and food consumption. This suggests that, in some contexts, financial inclusion can promote improved food security by increasing access to resources and opportunities (Baborska et al., 2020; Karki Nepal & Neupane, 2022). Ge et al. (2022) study the impact of the rural inclusive financial ecosystem on the income of rural households in China. The study found that digital inclusive finance has a positive role in increasing the income of rural residents. This further supports the

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potential of inclusive financial systems in improving the economic conditions of rural communities and their food security. This implies that inclusive finance contributes to improving the economic conditions of rural households, thereby positively impacting food security (Wang et al., 2023).

Regarding the construction of financial inclusion indicators, the existing literature focuses on the development level of rural inclusive finance refers to the "three-dimensional" indicator method for construction (Sarma & Pais, 2011). Yang & Fu (2019) defines the development of rural inclusive finance as the development of financial products and services in five aspects: "penetration," "usage," "utility," "quality," and "affordability," and constructs the index system for the development of rural inclusive finance. Chen et al. (2020) have chosen nine indicators from four dimensions, namely rural financial environment, rural economic development, rural investment environment, and urban-rural coordinated development, to establish an evaluation index system for the advancement of rural inclusive finance in China. Zheng et al. (2020) developed an evaluation index system for rural inclusive finance, taking into account the specific conditions in China. The system incorporates 22 indicators that assess the dimensions of usage, accessibility, and service efficiency. In their study, Wang et al. (2022) employ provincial-level indicators to examine the accessibility, usage, and utility of inclusive financial services in rural areas. They utilize the concepts of "breadth of coverage," "depth of usage," and "sustainability" to construct the rural inclusive finance index. Qi & Zhang (2023) selects indicators from the aspects of penetration, usage, and satisfaction, using micro-level data to construct the rural inclusive finance index at the village level. Some scholars also use the Digital Financial Inclusion Index (DFI) compiled by Peking University Digital Finance Research Center in collaboration with Ant Financial as the main proxy indicator when studying and evaluating the development of rural inclusive finance (Zhang & Xing, 2021; Ge et al., 2022; Lian, 2022). This index encompasses the extent of coverage, level of utilization, and extent of digitization of digital financial services, encompassing 31 provinces and 337 prefecture-level cities in China from 2011 to 2018, as well as 2800 counties (including county-level cities and districts) from 2014 to 2018. It offers a comprehensive representation of the present state of development of digital inclusive finance in China. Taking into account the actual situation of rural inclusive finance development and the availability of relevant data, this paper selects the indicators shown in Table 2 to construct the index system for the development of rural inclusive finance in China, based on a comprehensive review of the existing literature (Yang & Fu, 2019; Zheng

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et al., 2020; Qi & Zhang, 2023).

Food security involves numerous factors such as resources(Pinstrup-Andersen & Pandya-Lorch, 1998; Azizi, 2020), the environment(Tilman & Clark, 2015 ;El Bilali et al., 2019), technology(Tian et al., 2016 ; Dimitrova, 2022), and human capital(Ashraf & Javed, 2023), making it a systematic and complex issue. Scholars from various countries commonly use a comprehensive multi-index evaluation to measure food security. Based on the report of the Food and Agriculture Organization of the United Nations (FAO, 2006), several studies have comprehensively evaluated food security from the perspectives of supply, access, stability, and utilization (Subramaniam et al., 2019; Subramaniam et al., 2020; Calloway et al., 2023). Furthermore, some scholars suggest incorporating adaptability and sustainability into the conceptual framework of food security to reflect its long-term objectives (Béné et al., 2019; Clapp et al., 2022; Lee et al., 2023). As the internal and external environment of food security undergo significant changes in the new development stage, previous research on food security indicators has primarily focused on the quantity of food security, while giving less attention to food quality security, ecological environment security, economic security, and resource security. This approach is no longer adequate for assessing food security in the current development strategy. Consequently, some scholars have reconstructed the food security evaluation system. Lei & Qiu (2022) identified key obstacles affecting China's food security and established a food security evaluation index system based on five subsystems and 16 indicators, including quantity security, quality security, resource security, ecological security, and circulation security. Cui & Nie (2019) constructed a food security evaluation system based on the new era's perspective, including 14 indicators across five dimensions: quantity security, quality security, ecological environment security, economic security, and resource security.

Considering the Chinese government's high attention to food security and the developed transportation and logistics system in China, this study comprehensively draws on the research of Lei & Qiu (2022) and Cui & Nie (2019) to select 32 indicators across four dimensions: quantity security, quality security, resource security, and ecological security. This forms a comprehensive index system for measuring food security in various provinces of China.

The research on factors influencing food security has been conducted by many scholars. Godfray et al. (2010), Pu & Zhong(2020) and Lu et al. (2023) pointed out that population is an important factor affecting food security. The population directly affects food supply and access. In addition, Ingrao et al. (2023) also indicated that population

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growth may lead to an increased demand for irrigation water, resulting in water scarcity. This, in turn, affects agricultural productivity and, consequently, food security. Subramaniam et al. (2020) and Su et al. (2023) have pointed out that population, arable land, and industrial structure are directly related to the dynamics of supply and demand, as well as food security. Arable land resources are considered an important determinant of food security (Kastner et al., 2012; Liu et al., 2021; Lan et al., 2023). German et al. (2020) suggested that a diversified industrial structure can foster the development of agricultural enterprises and value chains, leading to improved food production efficiency, reduced post-harvest losses, and enhanced market access for farmers. Furthermore, research by Christiaensen et al. (2021) shows that advanced industrial sectors can promote technological innovation and research in agriculture, thereby increasing productivity and food supply. A sound supply chain and distribution system is usually associated with developed industrial structures, ensuring the efficient circulation of food from farms to consumers. Beddington (2010), Tomich et al. (2019) and Barrett (2021) have pointed out that research and development has a positive impact on food security. This includes improving agricultural productivity, enhancing climate change adaptation, and adopting more sustainable practices. Chandio et al. (2023) indicated that investment in agricultural research and development can lead to technological progress, improved crop varieties, and innovative farming methods. This, in turn, helps to increase food production and supply. Research shows that financial development has a positive impact on achieving fair and sustainable food security (Subramaniam et al., 2021; Arshad, 2022; Lin et al., 2022; Liu & Ren, 2023).

Most existing research focuses on the role of inclusive finance in poverty reduction (Yang & Fu, 2019a), narrowing income gaps(Yu & Wang, 2021), and economic growth(Corrado & Corrado, 2017), with studies on agricultural industrialization primarily centered on traditional fiscal support for the contribution of agricultural industrialization to farmers' income growth(X. Wang et al., 2019). There is a relative lack of research on the interrelation between rural inclusive finance and food security. Most literature concentrates on the impact of digital inclusive finance on the income of rural residents and the overall economic development level of rural agriculture, with inconclusive findings(Liu, Liu, et al., 2021; J. Lian, 2022; X. Lian et al., 2023) . Specific research on the impact of rural inclusive finance on food security remains scarce. Studying the relationship between rural inclusive finance and food security is of significant practical importance for further deepening the direction of rural inclusive finance reform, designing, and implementing specific intervention measures for rural inclusive finance

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to resolve the supply contradictions of rural finance and ensure food security.

3. MODELS AND DATA

3.1. Model

According to the notion of financial inclusion, increasing financial inclusion will allow for a greater number of farmers and individuals with low incomes to get financial instruments and improve their economic standing, which will in turn contribute to an increase in food security (Anju, 2018). Farmers will be able to increase their seed, fertilizer, and pesticide purchases, as well as their purchases of other production materials, if agricultural credit and other financial tools are made available to them, according to the agricultural production improvement theory (Udemezue & Osegbue, 2018). This will result in an increase in the overall effectiveness of agricultural production. This contributes to an increase in food production as well as an improvement in food supply. Drawing upon the aforementioned information, in our pursuit of a more precise evaluation of rural inclusive finance's influence on food security, we have formulated the subsequent multivariate model, building upon established methodologies:

〖"FS" 〗_(i,t)=f(〖"RIF" 〗_(i,t), 〖POP〗_(i,t), 〖LAND〗_(i,t), 〖IS〗_(i,t), 〖RD〗_(i,t), 〖RHC〗_(i,t), 〖FD〗_(i,t)) (1)

In this model, i and t pertain to the spatial dimension (specifically, the 30 provinces in China) and the temporal aspect (i.e., the particular year within our sampled timeframe), respectively. The variable designated as "FS" signifies food security, serving as the principal dependent variable in our study. Among the independent variables, "RIF" stands for Rural Inclusive Finance and serves as the core independent variable. POP stands for population, LAND for cultivated land area, IS for industrial structure, RD for R&D investment, RHC for the level of rural human capital, and FD represents finance development level.

Considering the heteroskedasticity, data fluctuation and estimation bias that may be caused by unit inconsistency in the estimation process, we treat some of the variables in equation (1) with natural logarithms as follows:

ln 〖"FS" 〗_(i,t)=α_0+α_1 ln 〖"RIF" 〗_(i,t)+α_2 ln 〖POP〗_(i,t)+α_3 ln 〖LAND〗_(i,t)+α_4 ln 〖IS〗_(i,t)+α_5 〖RD〗_(i,t)+α_6 ln 〖RHC〗_(i,t)+α_7 〖FD〗_(i,t)

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+η_i+〖μ_t+ε〗_(i,t) (2)

where ln denotes the natural logarithmic form of the variable, α_0 denotes the constant term, and α_1 - α_7 are the parameters to be estimated. η_i denotes an individual effect that is not affected by time, μ_t denotes a time effect, and ε_(i,t) denotes an independent and identically distributed error term (i.i.d).

Considering the potential time-lag effects and the lagged attributes associated with food security, our study employs a dynamic model to effectively capture the impact of rural inclusive finance. Consequently, the estimation model, incorporating the lagged term of the dependent variable, is structured as follows:

ln〖"FS" 〗_(i,t)=β_0+β_1 ln〖"FS" 〗_(i,t-1)+β_2 ln〖"RIF" 〗_(i,t)+β_3 ln〖POP〗_(i,t)+β_4 ln〖LAND〗_(i,t)+β_5 ln〖IS〗_(i,t)+β_6 ln〖RD〗_(i,t)+β_7 ln〖RHC〗_(i,t)+β_8 〖FD〗_(i,t)+η_i+〖μ_t+ε〗_(i,t) (3)

where β_0 denotes the intercept term and β_1 - β_8 are the parameters to be evaluated. It is worth noting that the coefficient (β_2) of the core independent variable "RIF" in equation (3) is expected to be positive.

3.2. Variable measurements and data sources

3.2.1. Dependent variable.

Food Security (FS). This paper is guided by the 'National Medium and Long-Term Food Security Plan (2008-2020)' and the 'National Rural Revitalization Strategy Plan (2018-2022)', drawing on the analytical frameworks and research findings of the United States Department of Agriculture, the Food and Agriculture Organization of the United Nations (FAO), and the European International Union (EIU). It evaluates regional food security from four aspects: Food Supply Security (FSS), Food Quality Security (FSQ), Food Resource Security (FSR), and Food Ecological Security (FSB), using the entropy method to determine the weights of various indicators to assess the food security status of 30 provinces and cities. The specific conditions of the 22 indicators across four dimensions are shown in Table 1. The relevant data come from various statistical yearbooks.

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Table 1 China's Food Security Evaluation Index System

System	Indicator Level	Indicator	Unit	Attribute
China's Grain Security Evaluation Index System	Quality Safety (*FSS*)	Total grain output	Ten thousand t	Positive
		Unit yield of grain per cultivated land area	kg/ hm^2	Positive
		Grain yield fluctuation coefficient	%	Negative
		Per capita grain production	Kg/person	Positive
		Degree of Dependence on Foreign Trade for Grain	%	Negative
		Domestic Grain Price Index	%	Negative
		Per capita disposable income of rural residents	Yuan/person	Positive
	Quality and safety (*FSQ*)	Amount of Pesticide Use	t	Negative
		Application amount of agricultural fertilizers	ten thousand t	Negative
		Usage of Agricultural Plastic Film	t	Negative
		Total amount of wastewater discharge	ten thousand t	Negative
	Resource Safety (*FSR*)	Per capita cultivated land area	hm^2/person	Positive
		Water Resources per Capita	m^3/person	Positive
		Irrigated Area (Effective) of Cultivated Land	ten thousand hm^2	Positive
		Fiscal Expenditure on Grain Production	100 million yuan	Positive
		Agricultural Machinery Total Power	ten thousand kW	Positive
		Agricultural Labor Force	ten thousand persons	Positive
		Agricultural Labor Productivity	%	Positive
	Ecological Safety(*FSB*)	Drainage area	ten thousand hm^2	Positive
		Saving Irrigation Area	ten thousand hm^2	Positive
		Crop Disaster-Affected Areas	Kilo-hectares	Negative
		Total Investment in Environmental Pollution Control	Billion Yuan	Positive

3.2.2. Independent Variables.

Rural Inclusive Financial Development Index (RIF). The China's 14th Five-Year Plan（2021–2025）points out that to improve the rural financial system and enhance the inclusiveness of rural finance, full attention must be paid to issues related to the

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coverage, accessibility, and satisfaction of financial services. This paper, drawing on existing studies(Yang & Fu, 2019; Zheng et al., 2020; Qi & Zhang, 2023), mainly constructs a new rural inclusive financial evaluation index system from four dimensions: 'penetration' ,'usage', 'utility' , 'quality' and calculates the rural inclusive financial development index. Specifically, the 'penetration' dimension mainly reflects the channels and convenience for farmers to access inclusive financial services, primarily measured by the number of financial institution outlets and the number of financial service personnel; 'usage' mainly measures farmers' acceptance of rural inclusive finance, with indicators such as farmers' deposits and agricultural loans reflecting the use of rural inclusive finance; 'utility' mainly reflects the contribution of deposit and loan services of rural financial institutions to rural economic development, and 'quality' mainly reflects the quality of deposit and loan services of rural financial institutions. The specific index system is detailed in Table 2.

Table 2: Index System for the Development of Rural Inclusive Finance in China

Dimension	Indicator	Unit	Attribute
Penetration	Number of rural financial institution outlets per 10,000 square kilometers	Outlets/10,000 km²	Positive
	Number of rural financial institution employees per 10,000 square kilometers	Persons/10,000 km²	Positive
	Number of rural financial institution outlets per 10,000 people	Outlets/10,000	Positive
	The number of rural financial institution outlets per 10,000 people.	Persons/10,000 km²	Positive
Usage	Annual per capita deposits in rural financial institutions	Ten thousand yuan/person	Positive
	Annual per capita loans from rural financial institutions Ten thousand yuan/person Positive	Ten thousand yuan/person	Positive
Utility	Ratio of deposit balance in rural financial institutions to added value of primary industry	%	Positive
	Ratio of loan balance in rural financial institutions to added value of primary industry	%	Positive
Quality	Loan-to-deposit ratio of rural financial institutions	%	Negative
	Non-performing loan rate of rural financial institutions	%	Negative

This paper uses the entropy method to determine the weights of the dimensions of the rural inclusive finance index system. The entropy method is an objective weighting method that assigns weight coefficients based on the degree of dispersion of indicators, avoiding interference from subjective factors. Specifically, indicators with a higher degree of dispersion are given higher weights, and vice versa. Since the

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application of the entropy method is already widespread, this paper does not elaborate on its construction steps, and the related processing follows the research process of Zhao et al. (2021).

3.2.3. Control Variables.

Additionally, the specific definitions of other variables (i.e., population, arable land area, industrial structure, R&D investment, rural human capital, and financial development) are seen in Table 1. The related data for these control variables come from CSY (2021).

3.3 Data Sources

This study selects provincial panel data from 30 provinces (municipalities, autonomous regions) for the years 2011—2020. Due to difficulties in data acquisition, our sample does not include Hong Kong, Macao, Taiwan, and Tibet. The data are sourced from the National Bureau of Statistics' 'China Statistical Yearbook', local government work reports, and statistical bulletins.

3.4 Descriptive Statistics

Table 3 shows the descriptive analysis of each variable used in this study. It displays the mean, standard deviation, minimum, and maximum values of each variable used. The highest Food Security Index (FS) is 0.656, while the lowest is 0.110. Meanwhile, there is a significant discrepancy between the different dimensions of food security, with the Food Quality Security Index having the highest mean value (0.723), and the Food Ecological Security Index the lowest, with a mean value of only 0.226. Additionally, the Rural Inclusive Financial Index ranges from a low of 0.140 to a high of 0.690, with a mean value of 0.397 and a standard deviation of 0.110.

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Table3. Definitions and descriptive statistics of the variables

	Variable	Indicator	Mean	SD	Min	Max
Dependent variable	Food security (*FS*)	composite index	0.277	0.122	0.110	0.656
	Quantity safety (*FSS*)	composite index	0.308	0.137	0.071	0.792
	Quality safety (*FSQ*)	composite index	0.723	0.186	0.171	0.997
	Resource safety (*FSR*)	composite index	0.252	0.125	0.019	0.626
	Ecological safety(*FSB*)	composite index	0.226	0.190	0.023	0.847
Independent variable	*Rural inclusive finance* (*RIF*)	composite index	0.397	0.110	0.140	0.690
Controlled variables	Population(*POP*)	End-of-year resident population(in ten thousand people)	8.206	0.741	6.342	9.443
	Land(*LAND*)	Grain sowing area(thousand hectares)	7.737	1.252	3.839	9.578
	Industrial structure(*IS*)	The proportion of added value of primary industry to GDP (%)	2.026	0.919	-1.309	3.250
	Technological innovation(*RD*)	RD intensity	0.017	0.011	0.004	0.064
	Human capital(*RHC*)	Average years of education in rural areas(years)	2.047	0.078	1.766	2.276
	Finance development(*FD*)	measured by The proportion of loan and deposit balances in GDP by province.	3.366	1.089	1.678	7.578

4. EMPIRICAL RESULTS

4.1. Benchmark regression

4.1.1. Estimating the impact of rural inclusive finance on food security

To examine the influence of rural inclusive finance on food security, this study undertakes estimations using a set of methodologies. These encompass three static models, namely the Ordinary Least Squares (OLS) model, Fixed Effects model, and Random Effects model, as well as two dynamic models, Differential Generalized Method of Moments (Diff-GMM) and System Generalized Method of Moments (SYS-GMM), as presented in Table 5. Given that static model estimation is prone to endogeneity issues, it necessitates the identification of appropriate instrumental variables (IVs) to address them. The Generalized Method of Moments (GMM) offers an innovative approach to IV selection. It leverages the lagged term of the independent

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variable as the IV, which can partially mitigate bidirectional causality concerns and minimize variable bias (Leszczensky & Wolbring, 2022). Furthermore, the GMM techniques encompass the D-GMM method pioneered by Arellano & Bond (1991) and the SYS-GMM method developed by Arellano & Bover (1995) and subsequently enhanced by Blundell & Bond (1998). In a comparative sense, the SYS-GMM approach enhances estimation efficiency and adeptly tackles issues related to endogeneity and weak instrumental variables(Bun & Windmeijer, 2010). Hence, this paper primarily employs the SYS-GMM method for estimation purposes, with the results of the other four methods also detailed in Table 4.

Prior to interpreting the outcomes of our dynamic panel estimation, it is imperative to address the Arellano-Bond (A-B) test and the Hansen test. The A-B test assesses autocorrelation patterns within the differenced error term, while the Hansen test validates our choice of instrumental variables (IVs). The results from the SYS-GMM estimation reveal that the P-values associated with the first-order (AR(1)) and second-order (AR(2)) autocorrelation tests are below 0.1 and above 0.1, respectively. These findings affirm the appropriateness of the estimation methodologies applied in this study. Furthermore, the P-value obtained from the Hansen test exceeds 0.1, providing empirical support for the validity of the instrumental variables employed in this research.

Table 4 Baseline regression results[DV=FS]

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	FE	RE	Diff-GMM	SYS-GMM
L.y					-1.227[-3.50]***	0.771[3.11]***
RIF	0.012[2.36]**	0.008[1.64]	0.023[6.95]***	0.022[11.25]***	0.064[5.30]***	0.020[2.29]**
lnPOP		-0.043[-3.13]***	-0.141[-1.37]	-0.025[-1.32]	-0.037[-0.17]	-0.090[-1.69]*
lnLAND		0.098[12.09]***	0.040[2.44]**	0.056[8.18]***	-0.028[-0.65]	0.070[1.82]*
lnIS		0.020[1.71]*	-0.001[-0.07]	-0.001[-0.07]	0.038[1.56]	-0.030[-1.70]*
RD		4.537[4.77]***	1.255[1.63]	0.961[1.82]*	-3.745[-1.80]*	2.284[1.27]
lnRHC		0.102[1.47]	0.008[0.20]	0.018[0.47]	-0.241[-3.32]***	-0.107[-0.84]
FD		-0.006[-0.83]	-0.003[-0.64]	-0.002[-0.45]	0.018[1.76]*	-0.014[-1.24]
Constant	0.200[5.99]***	-0.483[-2.95]***	0.942[1.09]	-0.143[-0.82]	-	0.422[1.04)
Observations	300	300	300	300	240	270
R-squared	0.018	0.641	0.707	0.694		
AR(1)					0.004	0.040
AR(2)					0.676	0.205
Hansen					0.158	0.288

Notes: t statistics in parentheses; ***,**, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

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From the regression results, the coefficient of rural inclusive finance (RIF) is significantly positive in all five methods, which means that every 1% increase in RIF will have a certain positive impact on food security in China. In the SYS-GMM estimation regression, every 1% increase in RIF will significantly increase food security by about 0.020%, which indicates that the development of rural inclusive finance in China will effectively promote food security.

4.1.2. Heterogeneity analysis of food security sub-indicators

In this section, we conduct an empirical analysis of rural inclusive finance's impact on the four facets of food security using the SYS-GMM approach. The empirical findings are presented in Table 5.

Table 5 Results of the effects of rural inclusive finance on the sub-indexes of food security. [SYS-GMM; DV=FS]

	FS	**FSS**	**FSQ**	**FSR**	**FSB**
	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM
FS_{t-1}	0.771***	0.384**	0.673***	0.739***	0.666***
	[3.11]	[2.42]	[15.39]	[2.67]	[5.04]
RIF	0.020**	0.029***	0.023***	0.027***	0.020***
	[2.29]	[4.33]	[6.74]	[3.18]	[3.12]
lnPOP	-0.090*	-0.042	-0.088***	-0.105***	-0.042
	[-1.69]	[-1.04]	[-5.01]	[-2.93]	[-1.45]
lnLAND	0.070*	0.050**	0.056***	0.038*	0.045**
	[1.82]	[2.03]	[3.20]	[1.84]	[2.16]
lnIS	-0.030*	-0.038*	-0.053***	-0.002	-0.000
	[-1.70]	[-1.91]	[-3.80]	[-0.09]	[-0.01]
RD	2.284	0.426	-0.552	-0.066	2.701**
	[1.27]	[0.50]	[-1.50]	[-0.04]	[2.22]
lnRHC	-0.107	-0.327***	-0.185**	-0.339*	-0.046
FD	[-0.84] -0.014 [-1.24]	[-3.87] 0.003 [0.45]	[-2.12] 0.007*** [2.69]	[-1.65] 0.005 [0.36]	[-0.27] -0.019** [-2.33]
cons	0.422	0.681**	0.849***	1.137***	0.055
	[1.04]	[2.01]	[4.38]	[2.61]	[0.13]
AR(1)	0.004	0.035	0.030	0.046	0.011
AR(2) *Hansen*	0.205 0.288	0.110 0.844	0.899 0.739	0.187 0.996	0.317 0.633
Sample	300	300	300	300	300

Notes: t statistics in parentheses; ***,**, and * denote statistical significance at the 1%, 5%,

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and 10% levels, respectively.

As shown in the table, China's rural inclusive finance is effective in enhancing food security in the four dimensions of quantity security (FSS), quality security (FSQ), resource security (FSR), and ecological security (FSB).

4.2. Robustness Tests

(1) Replacement model. Considering that the food security (dependent variable) measured in this paper takes values between 0 and 1, which meets the conditions of the restricted dependent variable model, the restricted variable model Tobit model is used to reevaluate the model (1), and the test is conducted using fixed effects. Table 7 shows the robustness regression results. Column (1) shows the estimation results of the Tobit model. Comparing the estimation results of the Tobit model and the benchmark model, the estimated coefficient of rural inclusive finance is still significantly positive. The estimation results after replacing the model are consistent with the findings of the benchmark results.

(2) Replacing the dependent variable food security measurement method.

There is more than one way to measure food security, so this paper uses the entropy weight TOPSIS method to measure food security and takes it as the dependent variable in a two-step systematic GMM regression as a way to conduct a robustness test. The estimation results are shown in column (2) of Table 6. The sign and significance of the estimated coefficients are consistent with the benchmark regression, showing that the results are robust.

(3) Replacement of core independent variables. Adopting the methodologies of (L. Zhang & Xing, 2021)and (H. Huang et al., 2022), this study utilizes provincial-level indicators from the Digital Financial Inclusion Index (DFI) compiled by the Digital Finance Research Center of Peking University as substitute variables for rural inclusive finance. This index encompasses the breadth of coverage, depth of usage, and degree of digitalization of digital financial services, comprehensively reflecting the current state of digital financial inclusion in China. The estimation results in column (3) of Table 6 indicate that rural inclusive finance has a significant positive impact on food security, with robust regression outcomes.

(4) Excluding the municipality sample. Considering that municipalities directly under the central government are significantly different from other provinces in terms of agricultural financial inputs, agricultural policy support, the level of agricultural

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economic development, and agricultural science and technology innovation. In this paper, we exclude the samples of Beijing, Chongqing, Shanghai and Tianjin, and use the remaining 260 samples for parameter estimation. The results are shown in Column (4) of Table 6. The estimated coefficients of rural inclusive finance are significantly positive at the 1% level after considering the control variables and fixed effects.

(5) Censoring the sample period.

Considering the missing data of some indicators in 2011 and the large degree of data affected by the epidemic in 2020, this paper deletes the data of these two years and selects the data during 2012-2019 for testing. The empirical results are shown in column (5) of Table 6, indicating that the results remain robust, i.e., rural inclusive finance contributes to food security.

Table 6: Robustness Test Results

	(1)	(2)	(3)	(4)	(5)
	Tobit model	replacement of DV	replacement of IV	exclusion of samples	reduction of time periods
FS_{t-1}	-	0.697***	0.521***	0.638***	0.366***
	-	[4.55]	[2.81]	[4.93]	[2.90]
RIF	0.022***	0.012*	0.032***	0.017***	0.017***
	[11.38]	[1.74]	[3.16]	[3.02]	[3.72]
lnPOP	-0.027	-0.143**	-0.001	-0.018	-0.047***
	[-1.34]	[-1.97]	[-0.11]	[-1.14]	[-2.99]
lnLAND	0.056***	0.108**	0.027**	0.043**	0.043***
	[7.96]	[2.05]	[2.41]	[2.58]	[3.42]
lnIS	-0.001	-0.044	0.023***	0.061***	0.017*
	[-0.08]	[-1.42]	[2.67]	[3.18]	[1.92]
RD	0.970*	4.489*	1.619***	-2.310	0.929*
	[1.86]	[1.81]	[3.36]	[-1.07]	[1.66]
lnRHC	0.018	-0.010	0.062	0.207	-0.072
	[0.46]	[-0.06]	[1.50]	[0.87]	[-0.62]
FD	-0.002	-0.013	-0.006***	-0.004	-0.006***
	[-0.45]	[-1.35]	[-4.70]	[-0.51]	[-2.89]
Constant	-0.121	0.420	-0.413**	-0.720	0.232
	[-0.64]	[0.88]	[-2.42]	[-1.45]	[0.87]
AR(1)		0.044	0.000	0.001	0.001
AR(2)		0.493	0.253	0.432	0.234
Hansen		0.873	1.000	0.786	0.461
Sample		270	270	234	210

Notes: t statistics in parentheses; ***,**, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The model（2）-（5）is estimated using the two-step model with robust estimation.

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4.3. Heterogeneity test

4.3.1 Geographic Perspective

Given China's vast span from east to west and significant regional disparities, it is imperative to divide the country into eastern, central, and western regions for heterogeneous analysis. The regional regression results, as shown in Table 7, with columns (1), (2), and (3) representing the estimated impacts of rural inclusive finance on food security in the eastern, central, and western regions, respectively, are derived using the two-step system GMM regression model. The findings indicate that rural inclusive finance significantly enhances food security across the east, central, and west. Compared with the national situation, the impact coefficient in the central region is significantly higher than that in the eastern and western regions, surpassing the national average. This suggests that the degree of influence of rural inclusive finance varies markedly across regions, with its promotional effect on food security diminishing from the central to the eastern and western regions.

4.3.2 Perspective of Major Grain-Producing Areas, Major Sales Areas, and Production-Sales Balanced Areas

Additionally, based on the natural resource endowments and food production conditions of each province, China has divided its 31 provinces (regions, municipalities) into three functional zones: major grain-producing areas, production-sales balanced areas, and major grain sales areas (excluding Hong Kong, Macao, and Taiwan)(Lee et al., 2023). The major grain-producing areas are the core of China's food production, supplying large volumes and bearing over 70% of the food output and approximately 80% of the commercial grain supply. Solving food security issues must first ensure the security and stability of food in these primary production areas. This study further investigates the impact of rural inclusive finance on food security in different functional zones, as seen in Table 7, columns (4)-(6), with impact coefficients of 0.017, 0.029, and 0.022, respectively. This indicates that although rural inclusive finance significantly promotes food security in major grain-producing areas, major sales areas, and production-sales balanced areas, the promotional effect is greater in the major sales areas and production-sales balanced areas than in the major grain-producing areas. The reason could be that the major grain-producing areas have

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strong food production capabilities, large-scale land cultivation, and frequent agricultural production activities. Compared with major sales areas and production-sales balanced areas, major grain-producing areas already possess relatively sophisticated agricultural machinery and equipment, resulting in a larger number of large-scale farmers and professional farmers whose primary income is from grain cultivation. Therefore, for farmers in the major sales areas with relatively complete production conditions and massive scales, the funds provided by rural inclusive finance do not significantly affect the increase in production factor inputs.

Table7: Heterogeneity test results. [DV: FS]

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Eastern	Central	Western	Grain Production Area	Grain Area Sales	Balanced Production and Sales Area
FS_{t-1}	0.678***	-0.989**	0.935***	1.107***	-0.209**	0.267**
	[3.34]	[-0.93]	[2.85]	[5.48]	[-1.94]	[0.51]
RIF	0.018**	0.033*	0.016**	0.017***	0.029*	0.022**
	[2.23]	[1.81]	[2.24]	[2.93]	[1.65]	[2.29]
lnPOP	-0.067*	-0.001	-0.109	-0.038	-0.076***	-0.038
	[-1.74]	[0.01]	[-1.38]	[-1.01]	[6.05]	[-0.45]
lnLAND	0.053*	0.328	0.147	0.004	0.027	-0.023
	[1.93]	[0.92]	[1.26]	[0.06]	[0.30]	[-0.26]
lnIS	-0.006	0.122	-0.042	0.078***	0.023	0.108
	[-0.17]	[1.32]	[-0.61]	[3.23]	[0.55]	[1.45]
RD	1.757	-	2.662	3.180***	-	-11.923
	[1.15]	-	[0.74]	[3.05]	-	[-1.86]
lnRHC	-0.325	0.925	-0.271	0.137	-0.405	0.544**
	[-0.85]	[0.88]	[-0.80]	[0.56]	[-1.10]	[1.97]
FD	-0.005	-0.022	0.019	-0.049***	0.022	-0.029
	[-0.76]	[-0.36]	[0.60]	[-2.98]	[-0.85]	[-0.77]
Constant	0.806	-4.493	-	-0.231	-	-0.603
	[0.85]	[-0.60]	-	[-0.21]	-	[-0.87]
AR(1)	0.091	0.000	0.027	0.002	0.043	0.070
AR(2)	0.718	0.798	0.329	0.431	0.909	0.272
Hansen	1.000	1.000	0.988	0.999	1.000	1.000
Sample	99	72	99	117	63	90

Notes: t statistics in parentheses; ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

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5. Conclusion

With the development and application of rural inclusive finance, an increasing number of rural areas have access to comprehensive financial services, including credit facilities. Concurrently, food security has emerged as a critical issue, and the expansion of rural inclusive finance has brought numerous financial conveniences for farmers engaged in the cultivation of food crops and other agricultural products. Exploring the impact of rural inclusive finance on food security holds significant policy implications. An in-depth understanding of these latter may allow even the bank managers and to improve the financial efficiency and it will help to deal with the new trends in financial sector (Azzabi, & Lahrichi, 2023) which will help to food security. This paper utilizes panel data from 30 provinces, autonomous regions, and municipalities across the nation (excluding Hong Kong, Macao, Taiwan, and Tibet) from 2010 to 2020 to analyze the relationship between rural inclusive finance and food security. The results indicate that, overall, rural inclusive finance has a relatively significant positive effect on food security, enhancing the level of food security in the regions where it is developed. From the perspective of the various dimensions of food security, rural inclusive finance has a positive correlation with food quantity security, quality security, resource security, and ecological security. Simultaneously, the impact of rural inclusive finance on food security in China exhibits certain regional heterogeneity.

Based on these findings, the following policy insights are drawn: Enhance the intrinsic functions and effectiveness of rural inclusive finance in the central and western regions. The development of inclusive finance encompasses the advantages of relying on financial institutions, government leadership, and a combination of marketization. The government needs to employ various measures to ensure the perfection of the rural inclusive finance system. Therefore, governments in the central and western regions should, on one hand, use policy instruments to assist various financial institutions in establishing and perfecting rural credit information platforms to reduce rural financial risks. On the other hand, they should organize professional institutions and researchers to develop characteristic projects suitable for the development of inclusive finance in different rural areas, attracting commercial financial institutions to actively participate in the construction of rural inclusive finance in the central, western, and northeastern regions by improving the return on financial investment.

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Provide comprehensive financial services tailored to the different stages of economic development in each province and the needs of various farmers and agro-industrial enterprises. Optimize the allocation of financial resources and utilize digital technology to enhance the efficiency of financial resource utilization. For small farmers and micro-agricultural enterprises, integrate traditional financial institutions with digital inclusive finance to address the uneconomical scale of loans from traditional financial institutions to micro-enterprises and farmers. Given the current high risks and uncertainties in rural finance, it is appropriate to advance the marketization of rural financial institutions, allowing the market to play a decisive role in the allocation of resources in rural financial institutions, and effectively solve the problems of difficult and expensive loans for agro-industrial enterprises.

Improve farmers' financial literacy and promote relevant training. Due to a relative lack of financial literacy, farmers may seek the necessary funds for development through informal channels, showing resistance to formal financial lending channels. This significantly restricts farmers' sources of funds, thereby limiting their investments in production. Therefore, it is essential to enhance farmers' financial literacy, encourage them to approach financial services with the right attitude, and fully utilize digital inclusive finance to reduce transaction costs and improve credit availability, helping farmers obtain low-cost loans more quickly and gain a competitive edge in the market.

REFERENCES

Ahmed U. I., Ying L., Bashir M. K., Abid M., & Zulfiqar F. (2017). Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PLOS ONE, 12*(10), e0185466. https://doi.org/10.1371/journal.pone.0185466

Anju P. (2018). *Financial Inclusion in the Digital Age. In Handbook of Blockchain, Digital Finance, and Inclusion, Volume 1* (pp. 57–89). Academic Press. https://doi.org/10.1016/B978-0-12-810441-5.00004-X

Arellano, M., & Bond, S. R. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The Review of Economic Studies, 58*, 277–297. https://doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics, 68*, 29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Arshad, A. (2022). Impact of financial inclusion on food security: Evidence from developing countries. *International Journal of Social Economics, 49*(3), 336–355. https://doi.org/10.1108/IJSE-08-2021-0462

Ashraf, J., & Javed, A. (2023). Food security and environmental degradation: Do institutional quality and human capital make a difference? *Journal of Environmental Management, 331*, 117330. https://doi.org/10.1016/j.jenvman.2023.117330

Azizi, D. (2020). Access and allocation in food governance, a decadal view 2008–2018. *International Environmental Agreements: Politics, Law and Economics, 20*(2), 323–338. https://doi.org/10.1007/s10784-020-09481-9

Azzabi, A., & Lahrichi, Y. (2023). Bank Performance Determinants: State of the Art and Future Research Avenues, *New Challenges in Accounting and Finance, 9*, 26-41. https://doi.org/10.32038/NCAF.2023.09.03

Baborska, R., Hernandez, E., Magrini, E., & Morales, -Opazo Cristian. (2020). The impact of financial inclusion on rural food security experience: A perspective from low- and middle-income countries. *Review of Development Finance, 10*(2), 1–18. https://doi.org/10.10520/ejc-rdfin-v10-n2-a1

Balana, B. B., Mekonnen, D., Haile, B., Hagos, F., Yimam, S., & Ringler, C. (2022). Demand and supply constraints of credit in smallholder farming: Evidence from Ethiopia and Tanzania. *World Development, 159*, 106033. https://doi.org/10.1016/j.worlddev.2022.106033

Barrett, C. B. (2021). Overcoming Global Food Security Challenges through Science and Solidarity. *American Journal of Agricultural Economics, 103*(2), 422–447. https://doi.org/10.1111/ajae.12160

Beddington, J. (2010). Food security: Contributions from science to a new and greener revolution. *Philosophical Transactions of the Royal Society B: Biological Sciences, 365*(1537), 61–71. https://doi.org/10.1098/rstb.2009.0201

Béné, C., Oosterveer, P., Lamotte, L., Brouwer, I. D., de Haan, S., Prager, S. D., Talsma, E. F., & Khoury, C. K. (2019). When food systems meet sustainability – Current narratives and implications for actions. *World Development, 113*, 116–130. https://doi.org/10.1016/j.worlddev.2018.08.011

Blundell, R., & Bond, S. R. (1998). *Initial conditions and moment restrictions in dynamic panel data models*. https://doi.org/10.1920/WP.IFS.1995.9517

Bun, M. J. G., & Windmeijer, F. (2010). The weak instrument problem of the system GMM estimator in dynamic panel data models. *The Econometrics Journal, 13*(1), 95–126. https://doi.org/10.1111/j.1368-423X.2009.00299.x

Calloway, E. E., Carpenter, L. R., Gargano, T., Sharp, J. L., & Yaroch, A. L. (2023). New measures to assess the “Other” three pillars of food security–availability, utilization, and stability. *International Journal of Behavioral Nutrition and Physical Activity, 20*(1), 51. https://doi.org/10.1186/s12966-023-01451-z

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Chandio, A. A., Jiang, Y., Akram, W., Ozturk, I., Rauf, A., Mirani, A. A., & Zhang, H. (2023). The impact of R&D investment on grain crops production in China: Analysing the role of agricultural credit and CO2 emissions. *International Journal of Finance & Economics, 28*(4), 4120–4138. https://doi.org/10.1002/ijfe.2638

Chen, A., He, H., Wang, J., Li, M., Guan, Q., & Hao, J. (2019). A Study on the Arable Land Demand for Food Security in China. *Sustainability, 11*(17), Article 17. https://doi.org/10.3390/su11174769

Chen, Y., Yin, X., & Jin, R. (2020). Spatio-temporal Heterogeneity and Factors Influencing of China's Rural Inclusive Finance. *Journal of Quantitative & Technological Economics, 37*(05), 44–59. https://doi.org/DOI:10.13653/j.cnki.jqte.2020.05.003

Christiaensen, L., Rutledge, Z., & Taylor, J. E. (2021). Viewpoint: The future of work in agri-food. *Food Policy, 99*, 101963. https://doi.org/10.1016/j.foodpol.2020.101963

Clapp, J., & Isakson, S. R. (2018). Risky Returns: The Implications of Financialization in the Food System. *Development and Change, 49*(2), 437–460. https://doi.org/10.1111/dech.12376

Clapp, J., Moseley, W. G., Burlingame, B., & Termine, P. (2022). Viewpoint: The case for a six-dimensional food security framework. *Food Policy, 106*, 102164. https://doi.org/10.1016/j.foodpol.2021.102164

Corrado, G., & Corrado, L. (2017). Inclusive finance for inclusive growth and development. *Current Opinion in Environmental Sustainability, 24*, 19–23. https://doi.org/10.1016/j.cosust.2017.01.013

CUI, M., & NIE, C. (2019). Study on Food Security in China Based on Evaluation Index System. *Bulletin of Chinese Academy of Sciences, 34*(8), 910–919.

Demir, A., Pesqué-Cela, V., Altunbas, Y., & Murinde, V. (2022). Fintech, financial inclusion and income inequality: A quantile regression approach. *The European Journal of Finance, 28*(1), 86–107. https://doi.org/10.1080/1351847X.2020.1772335

Dimitrova A. (2022). Technological Innovations in Agriculture as a Way to Increase Food Security. *Economic Thought journal, 6*, 692–704. https://doi.org/10.56497/etj2267604

Dong, K., Taghizadeh-Hesary, F., & Zhao, J. (2022). How inclusive financial development eradicates energy poverty in China? The role of technological innovation. *Energy Economics, 109*, 106007. https://doi.org/10.1016/j.eneco.2022.106007

El Bilali, H., Callenius, C., Strassner, C., & Probst, L. (2019). Food and nutrition security and sustainability transitions in food systems. *Food and Energy Security, 8*(2), e00154. https://doi.org/10.1002/fes3.154

FAO. (2006). *The State of Food and Agriculture, 2006: Food Aid for Food Security?* Food & Agriculture Org.

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Friedline, T., Naraharisetti, S., & Weaver, A. (2020). Digital Redlining: Poor Rural Communities' Access to Fintech and Implications for Financial Inclusion. *Journal of Poverty, 24*(5–6), 517–541. https://doi.org/10.1080/10875549.2019.1695162

Fróna, D., Szenderák, J., & Harangi-Rákos, M. (2019). The challenge of feeding the world. *Sustainability, 11*(20), 5816. https://doi.org/10.3390/su11205816

Ge, H., Tang, L., Zhou, X., Tang, D., & Boamah, V. (2022). Research on the Effect of Rural Inclusive Financial Ecological Environment on Rural Household Income in China. *International Journal of Environmental Research and Public Health, 19*(4), Article 4. https://doi.org/10.3390/ijerph19042486

German, L. A., Bonanno, A. M., Foster, L. C., & Cotula, L. (2020). "Inclusive business" in agriculture: Evidence from the evolution of agricultural value chains. *World Development, 134*, 105018. https://doi.org/10.1016/j.worlddev.2020.105018

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., & Toulmin, C. (2010). Food Security: The Challenge of Feeding 9 Billion People. *Science, 327*(5967), 812–818. https://doi.org/10.1126/science.1185383

Huang, H., Mbanyele, W., Fan, S., & Zhao, X. (2022). Digital financial inclusion and energy-environment performance: What can learn from China. *Structural Change and Economic Dynamics, 63*, 342–366. https://doi.org/10.1016/j.strueco.2022.10.007

Huang, J. (2021). Recognition of recent and mid-long term food security in China. *Issues in Agricultural Economy, 1*, 19–26.

Huang, S., & Nik Azman, N. H. (2023). Enhancing Food Security through Digital Inclusive Finance: Evidence from Agricultural Enterprises in China. International *Journal of Environmental Research and Public Health, 20*(4), Article 4. https://doi.org/10.3390/ijerph20042956

Ingrao, C., Strippoli, R., Lagioia, G., & Huisingh, D. (2023). Water scarcity in agriculture: An overview of causes, impacts and approaches for reducing the risks. *Heliyon, 9*(8), e18507. https://doi.org/10.1016/j.heliyon.2023.e18507

Jayasinghe, M. (2022). Food Security, Home-Grown Food Consumption and Economies of Scale. In M. Jayasinghe (Ed.), *Poverty, Food Consumption, and Economic Development* (pp. 43–62). Springer Nature. https://doi.org/10.1007/978-981-16-8743-3_4

Jiang, Q., Li, Y., & Si, H. (2022). Digital Economy Development and the Urban-Rural Income Gap: Intensifying or Reducing. *Land, 11*(11), 1–23. https://doi.org/10.3390/land11111980

Jiao, X., He, G., Zhenling, Shen, J., & Zhang, F. (2018). Agri-environment policy for grain production in China: Toward sustainable intensification. *China Agricultural Economic Review, 10*(01), 78–92. https://doi.org/10.1108/CAER-10-2017-0201

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Karki Nepal, A., & Neupane, N. (2022). Living in the flood plain: Can financial inclusion, productive assets and coping mechanism help reduce food insecurity? *Environmental Challenges, 6*, 100437. https://doi.org/10.1016/j.envc.2021.100437

Kastner, T., Rivas, M. J. I., Koch, W., & Nonhebel, S. (2012). Global changes in diets and the consequences for land requirements for food. *Proceedings of the National Academy of Sciences, 109*(18), 6868–6872. https://doi.org/10.1073/pnas.1117054109

Lan, Y., Xu, B., Huan, Y., Guo, J., Liu, X., Han, J., & Li, K. (2023). Food Security and Land Use under Sustainable Development Goals: Insights from Food Supply to Demand Side and Limited Arable Land in China. *Foods, 12*(22), 1–20. https://doi.org/10.3390/foods12224168

Ledgerwood, J., Earne, J., & Nelson, C. (2013). *The New Microfinance Handbook: A Financial Market System Perspective*. The World Bank. https://doi.org/10.1596/978-0-8213-8927-0

Lee, C.-C., Zeng, M., & Luo, K. (2023). Food security and digital economy in China: A pathway towards sustainable development. *Economic Analysis and Policy, 78*, 1106–1125. https://doi.org/10.1016/j.eap.2023.05.003

LEI, X., & QIU, R. (2022). Evaluation of food security in China based on entropy TOPSIS model and the diagnosis of its obstacle factors. *Journal of China Agricultural University, 27*(12), 1–14.

Leszczensky, L., & Wolbring, T. (2022). How to Deal With Reverse Causality Using Panel Data? Recommendations for Researchers Based on a Simulation Study. *Sociological Methods & Research, 51*(2), 837–865. https://doi.org/10.1177/0049124119882473

Li, J., Wu, Y., & Xiao, J. J. (2020). The impact of digital finance on household consumption: Evidence from China. *Economic Modelling, 86*, 317–326. https://doi.org/10.1016/j.econmod.2019.09.027

Lian, J. (2022). Digital Economy Development, Rural Inclusive Financeand Agricultural Economic Growth——Empirical Evidence from County Data in China. *China Soft Science, 05*, 134–146.

Lian, X., Mu, Y., & Zhang, W. (2023). Digital inclusive financial services and rural income: Evidence from China's major grain-producing regions. *Finance Research Letters, 53*, 103622. https://doi.org/10.1016/j.frl.2022.103622

Lin, Q., Dai, X., Cheng, Q., & Lin, W. (2022). Can Digital Inclusive Finance Promote Food Security? Evidence from China. *Sustainability, 14*(20), Article 20. https://doi.org/10.3390/su142013160

Liu, J., & Ren, Y. (2023). Can digital inclusive finance ensure food security while achieving low-carbon transformation in agricultural development? Evidence from China. *Journal of Cleaner Production, 418*, 138016. https://doi.org/10.1016/j.jclepro.2023.138016

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Liu, X., Xu, Y., Engel, B. A., Sun, S., Zhao, X., Wu, P., & Wang, Y. (2021). The impact of urbanization and aging on food security in developing countries: The view from Northwest China. *Journal of Cleaner Production, 292*, 126067. https://doi.org/10.1016/j.jclepro.2021.126067

Liu, Y., Liu, C., & Zhou, M. (2021). Does digital inclusive finance promote agricultural production for rural households in China? Research based on the Chinese family database (CFD). *China Agricultural Economic Review, 13*(2), 475–494. https://doi.org/10.1108/CAER-06-2020-0141

Liu, Y., Luan, L., Wu, W., Zhang, Z., & Hsu, Y. (2021). Can digital financial inclusion promote China's economic growth? *International Review of Financial Analysis, 78*, 101889. https://doi.org/10.1016/j.irfa.2021.101889

Liu, Y., Wan, Q., & Chen, W. (2023). Digital Inclusive Finance as a Catalyst for Rural Revitalization: An Empirical Analysis from the County Development Perspective in Hubei Province. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-023-01493-5

Lohana, S., Rashid, U. K. B., Nasuredin, J., & Kumar, V. (2019). Determinants of Financial Sustainability and Access to Finance among SMEs in Malaysia: A Pilot Study. *Management and Business Research Quarterly, 10*, 1-7. https://doi.org/10.32038/mbrq.2019.10.01

Lu, S., Lu, W., Xu, M., Taghizadeh-Hesary, F., & Tang, Y. (2023). Water-energy-food security under green finance constraints in Southwest China. *Energy Economics, 118*, 106478. https://doi.org/10.1016/j.eneco.2022.106478

Masters, G. W. N., Jeffrey Alwang ,. William A. (2021). *Economics of Agricultural Development: World Food Systems and Resource Use* (4th ed.). Routledge. https://doi.org/10.4324/9780429316999

Murendo, C., Murenje, G., Chivenge, P. P., & Mtetwa, R. (2021). Financial Inclusion, Nutrition and Socio-Economic Status Among Rural Households in Guruve and Mount Darwin Districts, Zimbabwe. *Journal of International Development, 33*(1), 86–108. https://doi.org/10.1002/jid.3513

Pinstrup-Andersen, P., & Pandya-Lorch, R. (1998). Food security and sustainable use of natural resources: A 2020 Vision. *Ecological Economics, 26*(1), 1–10. https://doi.org/10.1016/S0921-8009(97)00067-0

Pu, M., & Zhong, Y. (2020). Rising concerns over agricultural production as COVID-19 spreads: Lessons from China. *Global Food Security, 26*, 100409. https://doi.org/10.1016/j.gfs.2020.100409

Qi, H., & Zhang, J. (2023). Rural Inclusive Finance Development and the Sustainability of Poverty Reduction: Dual Perspectives Based on Multidimensional Relative Poverty and Poverty Vulnerability. *Inquiry into Economic Issues, 07*, 158–175.

Sarma, M., & Pais, J. (2011). Financial Inclusion and Development. *Journal of International Development, 23*(5), 613–628. https://doi.org/10.1002/jid.1698

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Su, F., Liu, Y., Chen, S.-J., & Fahad, S. (2023). Towards the impact of economic policy uncertainty on food security: Introducing a comprehensive heterogeneous framework for assessment. *Journal of Cleaner Production, 386*, 135792. https://doi.org/10.1016/j.jclepro.2022.135792

Su, T., Yu, Y., Chen, Y., & Zhang, J. (2019). The Experience, Dilemma, and Solutions of Sustainable Development of Inclusive Finance in Rural China: Based on the Perspective of Synergy. *Sustainability, 11*(21), Article 21. https://doi.org/10.3390/su11215984

Subramaniam, Y., Masron, T. A., & Azman, N. H. N. (2019). The impact of biofuels on food security. *International Economics, 160*, 72–83. https://doi.org/10.1016/j.inteco.2019.10.003

Subramaniam, Y., Masron, T. A., & Azman, N. H. N. (2020). Biofuels, environmental sustainability, and food security: A review of 51 countries. *Energy Research and Social Science, 68*. Scopus. https://doi.org/10.1016/j.erss.2020.101549

Subramaniam, Y., Masron, T. A., & Azman, N. H. N. (2021). Remittances and food security. *Journal of Economic Studies, 49*(4), 699–715. https://doi.org/10.1108/JES-05-2020-0239

Subramaniam, Y., Masron, T. A., Wahab, M. A., & Mia, M. A. (2021). The impact of microfinance on poverty and income inequality in developing countries. *Asian-Pacific Economic Literature, 35*(1), 36–48. https://doi.org/10.1111/apel.12326

Sun, X., Xiang, P., & Cong, K. (2023). Research on early warning and control measures for arable land resource security. *Land Use Policy, 128*, 106601. https://doi.org/10.1016/j.landusepol.2023.106601

Tian, J. (Jingxin), Bryksa, B. C., & Yada, R. Y. (2016). Feeding the world into the future – food and nutrition security: The role of food science and technology†. *Frontiers in Life Science, 9*(3), 155–166. https://doi.org/10.1080/21553769.2016.1174958

Tilman, D., & Clark, M. (2015). Food, Agriculture & the Environment: Can We Feed the World & Save the Earth? *Daedalus, 144*(4), 8–23. https://doi.org/10.1162/DAED_a_00350

Tomich, T. P., Lidder, P., Coley, M., Gollin, D., Meinzen-Dick, R., Webb, P., & Carberry, P. (2019). Food and agricultural innovation pathways for prosperity. *Agricultural Systems, 172*, 1–15. https://doi.org/10.1016/j.agsy.2018.01.002

Tong A., Jiang L., Ru Y., Hu Z., Xu Z., & Wang Y. (2022). Research on the impact of inclusive finance on agricultural green development: Empirical analysis of China's main grain producing areas. *PLOS ONE, 17*(9), e0274453. https://doi.org/10.1371/journal.pone.0274453

Udemezue, J., & Osegbue, E. (2018). Theories and Models of Agricultural Development. *Annals of Reviews and Research, 1*(5), 00134–00137.

Wang, J. (2023). Digital inclusive finance and rural revitalization. *Finance Research Letters, 57*, 104157. https://doi.org/10.1016/j.frl.2023.104157

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Wang L., Zhou J., Chen K., Yan L., & Tu Y. (2022). The impact of China's inclusive finance on multidimensional poverty in rural areas. *Progress in Geography, 41*(11), 1991–2003.

Wang, L., Zhou, J., Chen, K., Yan, L., & Tu, Y. (2022). The impact of China's inclusive finance on multidimensional poverty in rural areas. *Progress in Geography, 41*(11), 1991–2003. https://doi.org/10.18306/dlkxjz.2022.11.001

Wang, X., Shao, S., & Li, L. (2019). Agricultural inputs, urbanization, and urban-rural income disparity: Evidence from China. *China Economic Review, 55*, 67–84. https://doi.org/10.1016/j.chieco.2019.03.009

Wang, Y., Liu, J., Huang, H., Tan, Z., & Zhang, L. (2023). Does Digital Inclusive Finance Development Affect the Agricultural Multifunctionality Extension? *Evidence from China. Agriculture, 13*(4), Article 4. https://doi.org/10.3390/agriculture13040804

Yang, Y., & Fu, C. (2019a). Inclusive Financial Development and Multidimensional Poverty Reduction: An Empirical Assessment from Rural China. *Sustainability, 11*(7), Article 7. https://doi.org/10.3390/su11071900

Yang, Y., & Fu, C. (2019b). The Improvement Effect of China's Rural Inclusive Financial Development on the Multidimensional Poverty of Working-age Population in Rural Areas. *Chinese Rural Economy, 03*, 19–35.

Yu, C., Jia, N., Li, W., & Wu, R. (2021). Digital inclusive finance and rural consumption structure – evidence from Peking University digital inclusive financial index and China household finance survey. *China Agricultural Economic Review, 14*(1), 165–183. https://doi.org/10.1108/CAER-10-2020-0255

Yu, N., & Wang, Y. (2021). Can Digital Inclusive Finance Narrow the Chinese Urban–Rural Income Gap? The Perspective of the Regional Urban–Rural Income Structure. *Sustainability, 13*(11), Article 11. https://doi.org/10.3390/su13116427

Yu, X., Sun, J. X., Sun, S. K., Yang, F., Lu, Y. J., Wang, Y. B., Wu, F. J., & Liu, P. (2019). A comprehensive analysis of regional grain production characteristics in China from the scale and efficiency perspectives. *Journal of Cleaner Production, 212*, 610–621. https://doi.org/10.1016/j.jclepro.2018.12.063

Zhang, C., Li, Y., Yang, L., & Wang, Z. (2023). Does the Development of Digital Inclusive Finance Promote the Construction of Digital Villages?—An Empirical Study Based on the Chinese Experience. *Agriculture, 13*(8), Article 8. https://doi.org/10.3390/agriculture13081616

Zhang, L., & Xing, Z. (2021). Distribution Dynamics, Regional Differences and Convergence of Digital Inclusive Finance in Rural China. *Journal of Quantitative & Technological Economics, 03*, 23–42. https://doi.org/10.13653/j.cnki.jqte.20210201.001

Zhang, Z., Hou, L., Qian, Y., & Wan, X. (2022). Effect of Zero Growth of Fertilizer Action on Ecological Efficiency of Grain Production in China under the Background of Carbon

Submetido em: 13/03/2024
Aprovado em: 15/05/2024
Avaliação: Double Blind Review
ISSN: 2316-2880

Emission Reduction. *Sustainability, 14*(22), Article 22. https://doi.org/10.3390/su142215362

Zhao, J., Jiang, Q., Dong, X., & Dong, K. (2021). Assessing energy poverty and its effect on CO2 emissions: The case of China. *Energy Economics, 97*, 105191. https://doi.org/10.1016/j.eneco.2021.105191

Zheng, J., Yang, D., & Liu, Y. (2020). The measurement of rural inclusive finance development level and its spatial effect on the operational income of farmers. *Journal of Central China Normal University (Nat. Sci.), 54*(5), 862–873. https://doi.org/10.19603/j.cnki.1000-1190.2020.05.018

Zhu, X., Chen, X., Cai, J., Balezentis, A., Hu, R., & Streimikiene, D. (2021). Rural financial development, spatial spillover, and poverty reduction: Evidence from China. *Economic Research-Ekonomska Istraživanja, 34*(1), 3421–3439. https://doi.org/10.1080/1331677X.2021.1875859