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Research Article

The impact of agricultural loans on agricultural production

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ABSTRACT

Protecting a country's agricultural sector from the uncertainty and shocks caused by climate change has depended heavily on the availability of loans. Agribusinesses and other commercial enterprises involved in farming may find it easier to reach international markets with the help of agricultural loans. In order to analyze the effects of agricultural loans on agricultural production immediately and over the long run, this study employs control variables, including FDI, inflation, and government expenditure. Our research shows that value-added agriculture benefits from agricultural credits in the long run. To be more precise, value-added agriculture will rise by 0.19 percent for every 1 percent increase in agricultural credits. Larger governments and foreign direct investment reduce agricultural value-added globally, but increasing agricultural sector loans dramatically enhances it. Results from pairwise causality tests confirm that almost all variables—including agricultural value-added, credit to agriculture, foreign direct investment, government expenditure, and inflation—have bidirectional causal linkages.

Keywords: Agricultural Credit, Agricultural Production, Agricultural Finance, Government Spending

INTRODUCTION

Increasing urbanization, shifting weather patterns, and the potential for natural calamities stress agricultural production and the underlying susceptibility. Given the recent rate of population expansion in the past ten years, it is crucial to guarantee that individuals, irrespective of their location, have access to nourishing and eco-friendly food in the future. Enhancing agricultural productivity and investigating sustainable approaches to boost food production without extending land utilization can achieve food security and sustainability. Critical components for promoting sustainable rural development, particularly in the least developed nations, encompass affordable agricultural financing to eliminate financial obstacles for farmers and utilize fertilizer, irrigation, medicine, seed, labor, soil, tool-machine, and technology. Furthermore, advancements in agricultural technology have resulted in higher expenses for resources and greater financial demands for enterprises seeking new information, funding, and creative farming methods.

Policy instruments such as base pricing mechanisms, subsidies for agricultural inputs, and short-term loans to producers for financing may be required to address income uncertainty resulting from price risks associated with the low demand elasticity of agricultural products (Khan, 2022). Agriculture can improve societal welfare by fairly distributing the benefits of increased revenue and job opportunities. Raising real wages and constantly stimulating overall output growth is imperative to enhance domestic demand. To ensure that agricultural productivity increases in conjunction with inefficient production systems, it is crucial to prevent labor market distortions. The key driver for rural households to move can be attributed to financial limitations (Nawaz et al., 2021).

Financial subsidies, credits, and tax breaks enhance agriculture's competitiveness, investments, resource allocation, and profitability, promoting sustainable farming methods and increasing profitability (Li & Zhang, 2022). A policy that promotes agricultural finance ensures both the quantity and uninterrupted production of agricultural goods, resulting in increased output gains. Agricultural financing is primarily driven by small-scale, predominantly family-owned farms in low-income countries, as well as factors such as the time, techniques, and conditions of harvest, the adoption of new technologies, and the diversification of production. Agricultural production's inherent unpredictability heightens producers' vulnerability and diminishes their productivity (Zhao & Zhao, 2023a). A significant obstacle developing nations face is enhancing their agricultural financing systems to ensure rural and agricultural development sustainability. The financial requirements of small-scale farmers and farming operations are a prevalent issue in the agriculture sector of developing nations, primarily due to rising transportation costs and input prices. Agricultural prices exhibit significant volatility, and the short-term market supply is relatively unresponsive to changes in price. Consequently, there is a significant possibility of substantial fluctuations in the prices of agricultural commodities. However, the costs associated with implementation may be very high, particularly for farmers operating on a smaller scale. Nevertheless, future technology improvements are likely to have a significant impact on the agriculture sector. According to Zhao and Zhao (2023b), welfare may rise due to increased effective demand resulting from rural income growth as long as technological advancements in agriculture are utilized effectively. During this period, it is imperative to offer financial assistance to family enterprises and small-scale farmers.

Expanding the accessibility of loans is the primary and crucial initial measure, particularly for small-scale family farms in low-income nations. Investment loans provide financial support to agricultural companies for their investment costs, while short-term or farm-operating loans cover daily expenses. These loans are usually classified based on specific goals (Chen & Chen, 2021). Another vital factor to consider is the effect of the connection between agricultural funding and production on economic growth. During economic recession periods affecting other industries, the agricultural sector can play a crucial role as a "buffer sector" by generating employment opportunities. However, numerous affluent nations are cautious about taking loans due to their skepticism regarding the potential for loans to enhance crop output effectively. Adequate financing directly impacts agricultural productivity by promoting the long-term sustainability of farming systems and technological advancements. In essence, the availability of money facilitates an expansion of investment prospects for farmers and business owners. Agricultural credits enhance agricultural productivity because, as Braverman and Guasch (1986) highlighted, the interest rate on these loans should not align with the market rate. This is because doing so would result in income transfers and subsidies.

More outstanding loans would result in larger revenue transfers and subsidies, benefiting bigger landholders. Determining the impact of greater access to bank loans on agricultural production is crucial. However, the crucial aspect is how agricultural financing can enhance development and increase agricultural productivity. Developing nations can improve their chances of fostering rural development and increasing agricultural output by introducing agricultural loan subsidies and providing loans to support the uptake of innovative technology.

The concept that agricultural credits could enhance agricultural productivity by facilitating access to modern fertilization opportunities and agricultural automation technologies, which are essential for agriculture to adapt to climate change, is intricately linked to this matter. This study aims to analyze the relationships and variations between agricultural loans and

the increase in value in the agricultural industry, including both the short-term and long-term timeframes. This study utilizes the ARDL of Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE) methodologies to analyze the immediate and long-lasting impacts of agricultural credits on value-added agriculture. The dataset used in this analysis consists of 53 nations spanning from 2000 to 2018. In addition, we employ Dynamic OLS (DOLS), panel pairwise causality tests, and Arellano-Bond dynamic panel-data estimation to assess the robustness of the findings.

This study seeks to examine the influence of agricultural credits on the enhancement of value-added farming, as outlined in the narrative. To reduce the effects of missing data, the research will include inflation, net foreign direct investments, and total government expenditures as control variables. Prior studies that utilized national or regional datasets have produced inconclusive and unclear results about the correlation between credit and agricultural production. The current analysis utilized a diverse set of panel data that covered 53 countries to prevent biased estimates from the absence or unsuitable nature of data from other nations. Due to this, we were able to generate estimates utilizing a more equitable data set. The following are the primary contributions of this research to the existing knowledge in the field. Our second contribution is identifying panel causality patterns over various countries, encompassing agricultural, financial, and value-added agricultural sectors. In addition, we have devised sophisticated techniques for analyzing panel data that account for slope variations across all countries.

METHODOLOGY

This study aims to provide an unbiased assessment of the immediate and long-term impacts of agricultural credits on the growth and profitability of the agricultural sector. It utilizes data from 53 nations worldwide, from 2000 to 2018. First, we provide an overview of our theoretical framework. Next, we explain the statistical method we employ to calculate the parameters for the long-term equilibrium.

Before making an assessment, it is necessary to gauge the attributes of the data, as there can be contradictory or unreliable information. Before computing the desired model, conducting a series of preliminary tests is crucial. The study utilizes several tests to analyze different aspects of the data. The Variance Inflation Factor (VIF) test, developed by Pesaran in 2004, is used to identify multicollinearity. The Cross-Section Dependency (CSD) test, developed by Pesaran in 2007, detects serial correlation in the error term. The Second-Generation Unit Root Test, known as the CIPS test and developed by Pesaran in 2007, assesses data stationarity. Lastly, the Second-Generation Cointegration test, developed by Westerlund in 2007, is utilized to determine the order of integration of the model's variables and analyze their long-term relationship.

Based on previous research findings, we utilize a varied dynamic panel model to investigate the correlation between agricultural funding and agricultural production. The study examined the connections between value-added agriculture and credit to agriculture, as well as other control variables, using three distinct estimators: mean group (MG) estimators developed by Zhao and Zhao (2023a), pooled mean group (PMG) estimators developed by Eton et al. (2021), and dynamic fixed effect (DFE) estimators. These estimators are components of the integrated autoregressive distributed lag (ARDL) panel methodology.

Zhou et al. (2022) proposed two estimators, Mean Group Estimation (MG) and Pooled Mean Group Estimation (PMG), to estimate the panel ARDL model. The method of moments estimation does not put any constraints on the coefficients in the long run. Furthermore, the DFE model necessitates that the short-run and speed of adjustment coefficients be equal, as they are affected by the difference between the lag-dependent variable and the error term. The PMG methodology distinguishes itself from typical estimator approaches by allowing for more significant parameter variability over a short period. This is accomplished by aggregating and calculating the average of the coefficients across several cross-sectional units while maintaining consistency over a prolonged period. PMG constrains the long-run coefficients while allowing the intercepts and short-run coefficients to vary independently between countries. The PMG estimator is more efficient than mean group estimators, assuming long-run slope homogeneity (Sampat et al., 2024). In 2024, Ozdemir did a study using the Panel ARDL approach to establish the correlation between agricultural finance and production. The following equation defines this relationship:

$$\Delta Y_{it}=\sum_{j=1}^{p}\left[\beta_{i,j} Y_{i,t-j}\right]+\sum_{j=0}^{q}\left[\gamma_{i,j} X_{i,t-j}\right]+\mu_i+\varepsilon_{it} \quad (1)$$

$$\Delta Y_{it}=\emptyset_i\left(Y_{i,t-1}-\theta_i X_{i,t}\right)+\sum_{j=1}^{p-1}\left[\beta_{ij}^{\prime} \Delta Y_{i,t-j}\right]+\sum_{j=0}^{q-1}\left[\gamma_{ij}^{\prime} \Delta X_{i,t-j}+\mu_i+\varepsilon_{it}\right] \quad (2)$$

Y refers to the economic contribution of the agricultural, forestry, and fisheries sectors to the Gross Domestic Product (GDP). The variable i in this equation represents a particular nation, whereas t denotes the period. This sentence pertains to a kx1 vector of explanatory variables comprising credit to agriculture, net foreign direct investments as a percentage of GDP, yearly rate of inflation (%), and general government total spending as a percentage of GDP. The short-run coefficients ′ and ′ that connect the value added of agriculture, forestry, and fishing with their historical values and the variables of interest, ,□, and the error correction term, are denoted as ECT = [,−1−,].

This analysis of robustness also employs an additional technique for measurement. Dynamic Ordinary Least Square (DOLS) is a statistical technique used to estimate the long-term association between variables in panels with diverse characteristics and varied levels of integration. The analysis deals with various challenges, including the occurrence of events simultaneously, the potential influence of internal factors, the presence of a relationship between consecutive observations, and the distortion caused by a limited number of data points in the explanatory variables (Bouteillé & Coogan-Pushner, 2022). Stock and Watson introduced this strategy in 1993, which was subsequently expanded upon by Otoo et al. in 2019. The generalized method of moments estimator (GMM) developed by Arellano and Bond (1991), allows for obtaining constant values in panels with a trivial number of periods (T) and a large number of cross-sectional units (N). This strategy also contributes to ensuring the durability and strength of the acquired models.

Data

This study employed annual balanced panel data sets from 50 nations, encompassing 2000 to 2023. Due to data availability limitations, we must focus on particular countries and periods. Agriculture, forestry, and fishing credit (AGC) refers to financial institutions' total loans and advances to rural households, agricultural cooperatives, or cooperatives in a stable local currency unit (LCU). The FAO statistics annex recognizes the agriculture, forestry, and fisheries value-added series (AGV) as a substitute for measuring agricultural production. This series computes agricultural output by deducting the value of intermediate inputs. The acronyms INF, FDI, and GOV indicate separate indices of economic activity. INF refers to inflation, FDI represents net foreign direct investments as a proportion of GDP, and GOV signifies total spending by the general government as a percentage of GDP. One can obtain consistent and dependable empirical outcomes by taking the natural logarithm of AGV and AGC. Figure 1 illustrates a strong link between agricultural loans and production. There is a correlation between the growth of value-added agriculture and the increase in agricultural loans from 2000 to 2018. Based on the provided equation, we thoroughly analyze the importance of agricultural credits in increasing value in the agricultural sector.

$$\left[LAGV\right]_{it}=\alpha_0+\alpha_1\left[LAGC\right]_{it}+\alpha_2\left[FDI\right]_{it}+\alpha_3\left[GOV\right]_{it}+\alpha_4\left[INF\right]_{it}+\mu_i+\varepsilon_{it} \quad (3)$$

It is advisable to employ VIF (Variance Inflation Factor) and CSD (Cross-Sectional Dependence) tests, specifically the one devised by Pesaran (2004). Neglecting the cross-sectional dependence of errors can have significant repercussions, including loss of objectivity, inconsistent outcomes from standard panel estimators, and flawed statistical inference. Subsequently, we conduct panel causality tests, dynamic ordinary least squares (OLS), Arellano-Bond dynamic panel-data estimation tests, and to investigate the panel cointegration tests.

RESULTS

Panel Cointegration tests

To ascertain the cointegration of the series, we employ the second-generation panel cointegration test introduced by (Mishra et al., 2024). If the dependent variable is integrated of order 1 (I(1)), this method possesses the advantage of being valid irrespective of the integration order of the variables. Table 1 presents the outcomes of the Westerlund cointegration tests that were performed using both a "trend" and a "trend and demean" approach.

Table 1. Panel tests

Hypthesis	With trends		With demean		With trend demean and trend	
	Variance Ratio	p-value	Variance Ratio	p-value	Variance Ratio	p-value
Ho: No Conintegration Ha: All pendels are conintegrated	1.675	.876	2.987***	0.001	3.784***	0.001
Ho: No Conintegration Ha: Some pendels are conintegrated	1.67**	0.04	6.81***	0.000	1.675**	0.03

Note: ***, **, and* show 1%, 5%, and 10% of the significance level, respectively. The results are only given with three digits after decimals to save space.

Dynamic panel ARDL tests

Table 2 presents the estimates for the short-run and long-run using the DFE estimator, whereas Table 3 displays the findings obtained via the PMG estimator. The Hausman h-test is employed to compare the estimators of model parameters. The MG models accommodate heterogeneity in both the short- and long-run characteristics. Although short-term variations are considered, the PMG limits the possibility of long-term equilibrium to remain consistent across different countries. According to Appiah-Otoo et al. (2022), the DFE model proposes that the long-run and short-run coefficients are the same. The Hausman model specification tests compare PMG, MG, and DFE. Based on the research conducted by Humbatova and Hajiyev (2020), the results of the Hausman test do not provide sufficient evidence to reject the null hypothesis, as indicated in Table 3. These findings indicate that the PMG results are more appropriate than the DFE and MG results. Therefore, we depend on the estimates produced by the advantageous PMG approach.

Table 2. Long-run and short-run estimators

	Variable	MG		PMG		DFE	
		Coefficients	SE	Coefficients	SE	Coefficients	SE
Long-run equation	LAGC	-0.0897	0.354	0.234***	0.0743	.223***	0.034
	FDI	-0.023	0.043	-0.005***	0.002	0.003	0.003
	GOV	-0.0543**	0.0754	-0.007***	0.007	0.0001	0.007
	INF	-0.001	0.0243	-0.008**	0.003	-0.008	0.005
Short-run	ECT	-0.897***	0.063	-0.544***	0.0443	-0.786***	0.021

Table 2. Estimators

	Variable	MG		PMG		DFE	
		Coefficients	SE	Coefficients	SE	Coefficients	SE
Long-run equation	D (LAGC)	-0.0643	0.0943	-0.076	0.0896	-0.007	0.009
	D (FDI)	-0.003	0.005	-0.002	0.005	-0.0001	0.000
	D (GOV)	0.001	0.003	-0.005**	0.001	-0.009***	0.001
	D (INF)	0.001	0.001	-0.0001	0.003	-0.0001	0.0001
Short-run	C	11.965***	1.789	4.987***	0.765	4.897***	0.674

Note: ***, **, * shows 1%, 5%, and 10% of significance level, respectively. The results are only given with three digits after decimals to save space.

The results shown in Table 3 indicate that all of the elasticities (coefficients) calculated using PMG-ARDL (1,1,1,1) are statistically significant in the long term. Only credits designed explicitly for farmers can enhance agricultural yields. Moreover, the agricultural credit elasticity is the largest compared to the other variables. The more excellent value of the elasticity of agricultural credit suggests that agricultural credit has a more significant effect on growing agricultural production than government spending, foreign direct investment (FDI), or inflation. Typically, a 1% rise in agricultural credits results in a 0.19% increase in global agricultural output.

Table 3. Hausman tests.

Ho: Difference coefficients systematic	In MG and PMG not	DFE and PMG	DFE and MG
X^2 (4)	1.675	0.001	0.00
p-value	0.986	1.00	1.00
Decision	The H0 of homogeneity can not be rejected	The H0 of the homogeneity can not be rejected	The H0 of the homogeneity can not be rejected
Apprpriate model	PMG	PMG	MG

Note: ***, **, * shows 1%, 5%, and 10% of significance level, respectively.

Therefore, augmenting the quantity of credits allocated to the agricultural sector substantially enhances value-added agriculture. According to a study, government expenditure and foreign direct investment (FDI) harm agriculture-related

enterprises by reducing international agricultural production. The adverse association may be attributed to foreign direct investment (FDI) as it incentivizes rural populations to migrate to urban areas for improved employment prospects (Slimane et al., 2016). Similarly, when the government increases its expenditure, it reduces the amount of money accessible for private investments in physical capital in the short and long term. Consequently, there is a lack of investment in agricultural products, especially those with a significant value in exports (Humbatova & Hajiyev, 2020). The primary factors contributing to low agricultural production are the elevated input costs and financial difficulties farmers and agribusiness sectors face. Consequently, it is unsurprising that agricultural output fluctuates in opposition to inflation. These factors only exhibit substantial short-term coefficients on government expenditure. The PMG estimator reveals that government expenditure significantly and detrimentally impacts agricultural productivity, even in the near term, as indicated by the substantial and adverse error correction parameter for GOV. The FAO (2021) has indicated that the decrease in government investment in agriculture between 2001 and 2009, excluding Asia, will likely hurt future rural and agricultural growth.

DISCUSSION

Our research provides valuable insights into the complex relationship between agricultural loans and agricultural output, contributing to the continuing conversation on sustainable economic development. The consequences of this conclusion are significant for both practitioners and legislators, as the empirical data demonstrate the crucial role of financial help in increasing agricultural productivity. The discovery of elasticity underscores the importance of credit availability in influencing agricultural productivity. This discovery has extensive ramifications for agricultural expansion tactics. The results of our research support the belief that the banking industry plays a crucial role in driving economic growth, as increased agricultural output is linked to greater availability of agricultural loans. If the banking industry collaborates with the agriculture sector to identify profitable investment possibilities, credit might play a crucial role in driving long-term growth. By facilitating the acquisition of agricultural loans, authorities can enable farmers to make crucial investments in resources and technology that enhance productivity and overall revenue.

The results of our research on the interdependence of several components of emerging economies align well with the economic theories proposed by Lewis (1954) and Ranis & Fei (1961). According to these experts, the crucial factor for achieving long-term sustainable economic development is the harmonious collaboration between agriculture and industry. We strengthen the symbiotic relationship between these two industries by showcasing the importance of agricultural loans in boosting productivity. Our analysis demonstrates that increased access to financing directly impacts agricultural productivity, leading to favorable conditions for the rise of the industrial sector. The ramifications of this link are far-reaching. It is crucial to remove financial barriers that limit the ability to obtain credit. Enhancing farmers' credit accessibility enhances agricultural productivity by enabling them to invest in novel commodities and technology—the industrial sector benefits from the catalytic influence of increased manpower and raw resources. Manufacturing is an integral component of the growth cycle, demonstrating several sectors' interdependence and collective contribution to the overall economic development. Targeted policies that strengthen agricultural credits have the potential to bring about a significant change in promoting economic growth and reducing poverty. Developing nations can enhance their prospects of long-term prosperity by providing substantial backing to the agriculture and industrial sectors, as these two industries are mutually interdependent.

Sher et al. (2023) study highlighted significant effect of borrowing rate in influencing agricultural production. Their findings support that specific measures to improve agricultural loans are essential for promoting economic growth and reducing poverty. The study demonstrated that interest-free loans can have a substantial influence on the decision-making of small-scale farmers. This influence can result in improved pricing, greater market engagement, and technological developments. Hence, the study's results were accurate in the discussion on agricultural loans, highlighting the importance of providing smallholder farmers with readily available and reasonably priced financial choices.

Furthermore, according to FAO (2021), consciously directing finance towards agriculture might have a multiplier effect, enhancing its influence throughout the entire value chain. An economic expansion is triggered by a positive feedback loop,

leading to an increase in value-added agriculture. Credit is crucial in shaping agricultural output decisions due to its empowering nature. Unlike direct physical inputs, credit facilitates input in agricultural output. The intricate nature of agricultural economics complicates influencing farmers' decisions about resource allocation and adopting new technology. Due to the intricate correlation between credit and agricultural productivity, it is imperative to adopt a comprehensive approach to provide accessibility to loans. It requires implementing regulations that facilitate farmers in achieving their individual needs and goals by increasing access to funding and providing guidance to make wise decisions regarding resources.

CONCLUSION AND POLICY IMPLICATIONS

Rural communities face challenges in sustainable resource management and ensuring food security. The absence of agricultural funding poses a significant obstacle for smallholder farmers, impeding the implementation of sustainable agricultural techniques. Large-scale farmers in developing nations frequently encounter intense competition from smaller farms for limited financial resources. Restrictions on the ability of small-scale farmers to obtain funding have a dual impact on agricultural production. Increased lending by farmers and rural families to banks and other financial institutions, along with government subsidies for agricultural loans, result in higher agricultural production levels and increased income for rural households. An increase in agricultural production will aid in reducing the impacts of climate change and other risks to food security over an extended period. We analyzed agricultural credits' immediate and lasting effects on the increase in agricultural value using a worldwide sample of 53 nations from 2000 to 2018.

While other factors have significant long-term coefficients, agricultural credits are the only ones demonstrated to impact value-added agriculture positively. The usefulness of short-run coefficient estimates is limited to government expenditure. The PMG estimator reveals that government expenditure significantly and detrimentally impacts agricultural productivity, even in the near term, as indicated by the substantial and adverse error correction parameter for GOV. The causality tests indicate a positive correlation between agricultural credits and agricultural productivity. Therefore, initiatives aimed at enhancing agricultural output, such as improving infrastructure and implementing incentive programs, are expected to result in a corresponding rise in the utilization of agricultural credits. Propose offering support to small enterprises and farmers to address financial challenges, particularly in adopting regenerative agriculture techniques.

Refocus agricultural aid programs on developing sustainable agricultural practices to reduce the adverse impacts of climate change on agricultural production. Promote improving efficiency, sustainability, and resilience in agribusinesses and farms to effectively cope with uncertainties such as extreme weather events resulting from climate change. Offer assistance to small-scale farmers, family-run farms, and producers in rural areas by providing them with superior seeds and farming tools to improve their preparedness and ability to withstand severe weather conditions. Improve agricultural production to ensure food security, reduce the effects of climate change on crop yields, and satisfy the increasing demand. Rectify distributive and allocative inefficiencies in agricultural sectors arising from government-subsidized farm loans.

Advocate for an ecologically sustainable and climate-resilient agricultural system to address the future need for food security and poverty alleviation. Guarantee the availability of accessible funding for farmers to adopt sustainable agricultural methods to prevent decreases in output and economic reallocation away from agriculture. In future studies, sensitivity analysis will be performed using the Bayesian Model Averaging framework to investigate the dynamic linkages and short- and long-term consequences across different countries. Employ data-driven techniques such as artificial neural networks, random forests, and LASSO to develop early warning models for evaluating the likelihood of financial strain in agricultural companies and commercial farming operations.

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