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ARTICLE

The Impact of Business Cycle on Economic Growth in Selected Five African Countries: A Dynamic Panel Data Analysis

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ABSTRACT

This study investigates the impact of business cycles on agricultural economic growth in Nigeria, South Africa, Egypt, Algeria, and Kenya from 2001 to 2021, providing critical insights into how macroeconomic fluctuations influence agribusiness investment, food security, and trade stability in Africa. The research is grounded in the need to understand the asymmetric effects of economic dynamics in diverse African contexts, where agriculture remains a vital sector for development and livelihoods. Utilizing dynamic panel data analysis via the Generalized Method of Moments (GMM), the study examines the roles of interest rates, inflation, foreign direct investment (FDI), and exchange rate volatility on agricultural Gross Domestic Product (GDP) in both short-term and long-term perspectives. Findings indicate that interest rates, FDI, and moderate inflation positively contribute to short-term growth, while exchange rate fluctuations and economic downturns hamper agribusiness financing and food security. Long-term growth relies heavily on sustaining FDI inflows and maintaining stable interest rate policies. By applying GMM, this research advances understanding of the complex, dynamic relationships between business cycles and agricultural development, offering valuable insights into strengthening the resilience of rural economies. The study concludes that policymakers should implement targeted monetary strategies that stabilize investment environments, promote FDI, and control inflation to foster sustainable agricultural growth, ensure food security, and enhance eco-

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nomic stability across the studied countries.

Keywords: Business Cycle; Agricultural Growth; Foreign Direct Investment; Interest Rates; Agricultural Trade; Inflation; Food Security

1. Introduction

Business cycles, characterized by periods of expansion and contraction, play a significant role in shaping economic growth, particularly in developing economies where volatility can be more pronounced [1]. Agriculture remains a crucial sector in economic development, influenced by various macroeconomic factors and business cycles. The interplay between economic growth and agricultural productivity determines the stability of food markets and rural employment [2]. This study examines the influence of macroeconomic factors, including interest rates, inflation, and foreign direct investment (FDI), on agricultural financing and market stability. Additionally, it examines how business cycles affect agricultural trade and food security, shaping economic resilience in rural areas. Macroeconomic indicators, such as interest rates, inflation, exchange rates, and FDI, are crucial in influencing these cycles and the broader economic landscape. While previous studies have focused on developed economies [3], there is a lack of research on African countries, where economic dynamics differ significantly [4]. This body of research has enabled policymakers to design and implement strategies that mitigate economic volatility and promote sustained resilience [5].

In contrast, many African economies exhibit distinct and often more volatile economic dynamics, stemming from structural challenges such as heavy reliance on commodity exports, underdeveloped financial and infrastructural systems, and heightened exposure to external shocks [6, 7]. Although the importance of macroeconomic stability is well acknowledged, limited empirical research has systematically examined how business cycles influence economic growth in the African context, particularly within the agricultural sector [8, 9]. Agriculture remains a cornerstone of development in Africa, contributing substantially to employment, rural livelihoods, food security, and national output [10, 11]. However, its performance and resilience are highly sensitive to macroeconomic fluctuations, which can either catalyze investment and productivity or deepen existing vulnerabilities.

Empirical evidence from developed economies suggests that macroeconomic stability supports sustainable economic growth and mitigates the adverse effects of cyclical downturns [12, 13]. However, these findings cannot be directly generalized to African settings due to differences in institutional capacity, economic structures, and policy responses. In particular, the economic implications of interest rate shifts, inflation volatility, and exchange rate instability on agricultural output and food security may vary significantly across African countries [14, 15]. This underscores the pressing need for context-specific analysis. This study aims to address this gap by investigating the dynamic relationship between business cycles and agricultural economic growth in five African economies Nigeria, South Africa, Egypt, Algeria, and Kenya over the period 2001 to 2021. It examines the extent to which macroeconomic indicators, such as interest rates, inflation, exchange rates, and FDI, influence agricultural growth, with attention to both short-term cyclical effects and long-term development trends. The study employs the Generalized Method of Moments (GMM), an econometric technique particularly suitable for panel data with endogeneity and heterogeneity issues [16, 17]. By offering nuanced insights into these complex interactions, the findings are expected to inform policy strategies that enhance agricultural resilience, support sustainable economic development, and strengthen food security amid business cycle volatility across the African continent.

1.1. Research Questions and Hypotheses

To guide the empirical investigation and ensure analytical clarity, this study articulates the following research questions:

RQ1: What is the short-term impact of interest rate fluctuations on agricultural GDP in selected African countries?

RQ2: How do FDI inflows contribute to the sustainability and expansion of agribusinesses?

RQ3: In what ways does exchange rate volatility influence agricultural trade and productivity across diverse business cycle phases?

RQ4: How do macroeconomic conditions interact with business cycles to affect food security outcomes?

Based on these questions and the literature reviewed, the following testable hypotheses are proposed:

H1. *Stable interest rates have a positive effect on agricultural productivity in African economies.*

H2. *Higher FDI inflows significantly enhance food security by increasing investment in agribusiness value chains.*

H3. *Exchange rate volatility has a negative impact on the growth of agricultural trade and export performance.*

H4. *Business cycle expansions are associated with improved agricultural GDP, while contractions intensify food insecurity.*

1.2. Theoretical Framework

This study is anchored in a multidisciplinary theoretical framework that combines neoclassical growth theory, endogenous growth theory, and agribusiness development models, providing a comprehensive understanding of how macroeconomic factors and business cycles impact agricultural growth in Africa.

1.2.1. Neoclassical Growth Theory (Solow Model)

The Solow growth model posits that long-run economic growth is driven by capital accumulation, labour force growth, and exogenous technological change. In the context of agriculture, this suggests that increased capital investment and technological innovation enhance productivity and output. However, due to diminishing returns to capital, growth can stagnate without continuous technological improvements [12]. This model underpins the need for sustained investment in infrastructure and equipment in the agricultural sector.

1.2.2. Endogenous Growth Theory

In contrast to the Solow model, endogenous growth theories argue that technological progress is generated internally through human capital, research and development (R&D), and institutional quality [18, 19]. These factors are especially relevant in Africa, where knowledge transfer, extension services, and the adoption of innovation determine how well farmers respond to macroeconomic shocks. The work of Cai and Menegaki [20] on FDI and macroeconomic volatility emphasizes that policy uncertainty and institutional instability can obstruct the growth-enhancing potential of external investment, which is crucial in agricultural economies.

1.2.3. Agricultural Value Chain Framework

This study also draws from the Agricultural Value Chain (AVC) framework, which emphasizes the interconnected processes of input supply, production, processing, distribution, and marketing. Each stage is influenced by macroeconomic variables; interest rates affect credit access; inflation impacts input costs; and exchange rates affect export competitiveness. This aligns with the observation in Menegaki [21] that the structure of macroeconomic shocks and the dynamic adjustments along the chain must be captured using advanced econometric models, such as GMM.

1.2.4. Integration with Business Cycle Theory

Business cycle theory adds another layer by explaining how expansions and contractions in the economy (due to external shocks, policy changes, or global demand) influence investment patterns, resource allocation, and food security. For example, inflationary pressures during a downturn may reduce farmers' purchasing power, while booms might temporarily improve access to credit. Dynamic modelling is therefore necessary to capture these short-run fluctuations and long-run trends in agricultural productivity.

2. Literature Review

While previous studies have examined the effects of macroeconomic instability on economic performance, many have overlooked the specific vulnerabilities and structural characteristics of African economies, particularly within the agricultural sector. For example, Hasanov and Izraeli [22] utilized dynamic panel estimation to identify broad determinants of economic growth but did not disaggregate the impacts at the sectoral level, such as agriculture. Likewise, Acemoglu [23] provided valuable theoretical foundations for long-run growth; however, their models assume institutional and structural homogeneity, which limits their direct applicability to African contexts where volatility and structural constraints are more pronounced. More recent contributions, such as the study by Codina [24], have begun to integrate business cycle metrics with sector-specific resilience indicators, presenting a more context-appropriate analytical framework. Building on these advancements, this study addresses a critical gap by focusing specifically on agriculture within highly volatile macroeconomic environments, employing the GMM to account for endogeneity, dynamic relationships, and data heterogeneity unique to selected African economies.

Macroeconomic indicators play a significant role in agricultural productivity and financing. Research suggests that interest rates have a direct impact on farm investments, with higher rates discouraging agricultural loans and expansion [25]. Inflation affects input costs, leading to fluctuations in agricultural production and food prices [26]. Furthermore, FDI in agribusiness has been linked to technological advancements and increased market competitiveness [27].

Business cycles impact agribusiness investment and rural employment. Economic booms encourage expansion in agribusiness, while downturns result in reduced investments and job losses in rural economies [28]. Agricultural trade is highly sensitive to exchange rate fluctuations, which affect import-export competitiveness [29]. During economic downturns, food security is at risk due to declining agricultural innovation and disruptions in supply chains [30].

This prominence in GDP underscores the importance of understanding the factors that contribute to economic growth. A study was conducted utilizing data from 1986 to 2010 and employed multiple regression techniques, revealing a significant impact of various factors on GDP growth rates [31].

Among these factors, interest rates have been shown to have a significant influence on economic output in Nigeria. Oluwatoyese et al. [32] analyzed World Bank data spanning from 1981 to 2013, utilizing Unit Root Tests, Granger Causality Tests, and regression analysis. Their findings highlighted that interest rates are significant variables affecting economic performance. Although their study primarily focused on the agricultural sector, this indicates a need for further exploration across other sectors.

In contrast, the relationship between exchange rates and economic output has yielded inconclusive results. While Oluwatoyese et al. [32] found no significant relationship using a multivariate co-integration approach, Galadima and Aminu [33] supported this view by indicating that exchange rate shocks do not significantly impact economic output in either the short or long run. However, Lawal et al. [34] employed an autoregressive-distributed lag model, revealing a statistically significant negative relationship between exchange rates and economic output, specifically within the manufacturing sector. This discrepancy suggests that the impact of exchange rates may vary across different economic segments.

Furthermore, FDI is widely recognized as a catalyst for economic growth, particularly in developing regions like Africa. FDI contributes not only by injecting capital but also by facilitating technology transfer and enhancing managerial expertise. Asiedu [35] noted that the impact of FDI on economic growth in Africa is contingent upon factors such as institutional quality, governance standards, and macroeconomic stability. Recent studies have further explored this relationship; for instance, Opeyemi [36] observed that while FDI positively influences economic growth, high inflation rates can negate these benefits by creating an unstable economic environment. However, this study primarily focused on comparisons between emerging and developing countries, leaving a gap for regional analysis within Nigeria. Businesses can benefit from more effective support mechanisms, thereby enhancing their capacity to navigate the financial ecosystem. Additionally, the role of financial literacy emerges as a crucial element, with studies indicating that a lack of financial knowledge can hinder both access and effective management of financial resources [37].

Moreover, according to Brenner [38], FDI is widely considered an important driver of economic growth. Its effects, however, differ between less developed and more developed countries due to variations in institutional frameworks, infrastructure, and existing economic conditions. This suggests that FDI is a vital source of growth, especially for less developed countries, where it can significantly enhance capital, technology, and infrastructure. However, in more developed economies, the effects of FDI are less direct and often contribute to innovation and market expansion rather than fundamental growth. The key to maximizing the impact of FDI lies in creating favourable policies and a stable institutional environment to absorb and utilize these investments effectively.

Lawal et al. [34] utilized data from 1986 to 2019 and found a statistically significant negative relationship between inflation rates and economic output within the manufacturing sector. This finding highlights the complex interplay between economic indicators and underscores the need to extend the analysis to consider Nigeria's aggregate economic output. The Phillips curve relationship suggests that inflation can stimulate growth in the short run, but long-term inflationary pressures erode real incomes, increase uncertainty, and dampen investment incentives [34]. Studies utilizing SYS-GMM estimation confirm that inflation has a nonlinear relationship with growth, with thresholds beyond which inflation becomes harmful.

3. Materials and Methods

Using secondary panel data from 2001 to 2021, collected from sources such as the World Bank and national statistics agencies, this study examines the relationships between interest rates, inflation, exchange rates, FDI, and GDP. The GMM is applied to account for potential endogeneity and unobserved heterogeneity across the selected countries, ensuring robust results [39]. This dynamic panel approach enables an understanding of how past values of economic indicators influence current growth trends. Static panel models [Fixed Effect Model (FEM) and Random Effect Model (REM)] are commonly used to control for heterogeneity across countries. However, they fall short when lagged dependent variables and endogenous regressors are present, which is often the case in macroeconomic studies. Hence, this study adopts GMM estimators to address autocorrelation, endogeneity, and measurement errors. The First-Difference GMM [40] and the System GMM [17] are applied to ensure robust estimation of short-run and long-run dynamics. The analytical framework for this study, as depicted in **Figure 1**, illustrates how macroeconomic shocks—including exchange rate fluctuations, foreign direct investment (FDI), and interest rate variations—influence business cycles, which subsequently affect agricultural investment and productivity, ultimately impacting agricultural output and food security outcomes.

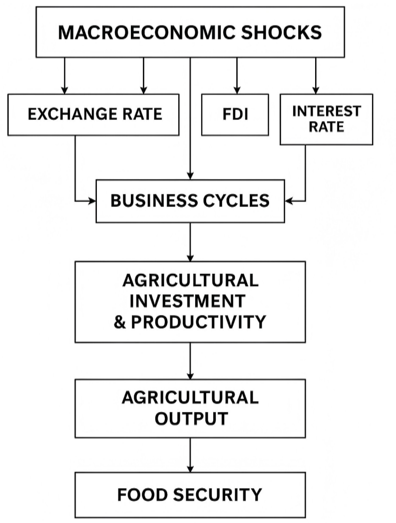

Figure 1. The conceptual framework.

Adopted from Sule et al. [41].

3.1. Regression of Dynamic Panel Data

This is the method of regression, which adds the dependent variable as an independent variable. The Equation (1) of this model can be formulated as follows:

$$y_{i,t} = \delta y_{i,t-1} + X'_{i.t}\beta + u_{i,t} \tag{1}$$

Where:

$y_{i,t}$: Observed unit in order-*i* at the period of t

δ : The coefficient of explanatory endogen variable

$X'_{i,t}$: The vector of observation on independent variable (1xK)

β : The vector of observation on predictor variable (1xK)

$u_{i,t}$: Panel regression error for Observed unit in order-*i* at the period of t

Through $u_{i,t}\sim$ IIDN (0, σ^2) with the index valued as 1, 2, ..., T. The index of *i* showed the dimension of observation, and the index of *t showed* the dimension of the time series. If $y_{i,t}$is defined as the function of *u* so that $y_{i,t-1}$can be functioned as $u_{i,t}$. Therefore, the regression on the right side (endogen explanatory) $y_{i,t}$correlated to$u_{i,t}$. Finally, if the model equation of dynamic panel data is treated as a static data panel model through OLS, it will cause biases and inconsistency [42].

3.2. Generalized Method of Moments (GMM)

Following the methodology of Verbeek [43], this study employed the method of dynamic panel data analysis using GMM. It aims to control for the biases associated with simultaneity and individual effects emanating from each country. GMM was developed by Manuel Arellano and Stephen Bond and is therefore also referred to as the Arellano–Bond estimator, which is defined as the GMM for estimating dynamic models of panel data. It was proposed in 1991 by Manuel Arellano and Stephen Bond, based on the earlier work of Alok Bhargava and John Denis Sargan in 1983, to solve certain endogeneity problems.

There are two estimation techniques commonly used in GMM, namely the First Difference of General Method of Moments (FD-GMM) and SYS-GMM. FD-GMM is used to solve the problem of lagged dependent variables versus the error component that does not maintain correlation. As with the Arellano-Bond method, the first difference of the regression equation is taken to eliminate the individual effects. Then, lower lags of the dependent variable are used as instruments for differenced lags of the dependent variable (which are endogenous). The SYS-GMM estimator is a system that includes both the level equations and the first-difference equations. It offers an alternative to the standard GMM estimator for the first difference.

3.3. The Method of GMM Arellano-Bond

This estimation method is also known as FD-GMM. FD-GMM, as proposed by Arellano-Bond, leads to an unbiased, consistent, and efficient estimate. The result of Arellano-Bond's one-step GMM estimator can be formulated as follows in Equation (2) [43].

Where: $\frac{\widehat{\delta}}{\widehat{\beta}} =$

$$\begin{gathered}\lfloor (N^{-1}\sum_{i=1}^{N}(\Delta y_{i,t},\Delta x_i)'z_i)\widehat{W}\\ (N^{-1}\sum_{i=1}^{N}Z_i'\Delta y_{i,t-1},\Delta x_i)\rfloor\\ ^{-1}[(N^{-1}\sum_{i=1}^{N}(\Delta y_{it-1},\Delta x_i)'Z_i)\\ \widehat{W}(N^{-1}\sum_{i=1}^{N}Z_i'\Delta y_i)]\end{gathered} \tag{2}$$

Z_i' : Instrument matrix

$\widehat{W}$: The unbiased and consistent estimation of $W_{(L\times L)}$ where L is the total number of instrument variables.

3.4. The Method of SYS-GMM

Blundell Bond's SYS-GMM estimator is used to estimate the system of equations by combining the first-difference with the moment-level condition. The GMM estimator δ can be obtained by minimizing the square function with the value J(δ) as shown in the following Equation (3) [44].

$$\begin{gathered}\frac{\partial J(\widehat{\delta})}{\partial\widehat{\delta}} = 2[(N^{-1}\sum_{i=1}^{N}\varphi_{i,-1}'Z_{sys})\\ \widehat{W}(N^{-1}\sum_{i=1}^{N}Z_{sys}'\varphi_i)]\\ +2[(N^{-1}\sum_{i=1}^{N}\varphi_{i,-1}'Z_{sys})\\ \widehat{W}(N^{-1}\sum_{i=1}^{N}Z_{sys}'\varphi_i\widehat{\delta})] = 0\end{gathered} \tag{3}$$

Where:

Z_{sys} : Instrument matrix

$\widehat{W}$: The unbiased and consistent estimation of $\mathbf{W}_{(L\times L)}$ where L is the total number of instrument variables.

So that one-step estimator system can be formulated as follows inEquation (4).

$$\begin{gathered}\widehat{\delta} = [(N^{-1}\sum_{i=1}^{N}\varphi_{i,-1}'Z_{sys})\\ \widehat{W}(N^{-1}\sum_{i=1}^{N}Z_{sys}'\varphi_i)]\\ ^{-1}[(N^{-1}\sum_{i=1}^{N}\varphi_{i,-1}'Z_{sys})\\ \widehat{W}(N^{-1}\sum_{i=1}^{N}Z_{sys}'\varphi_i)]\end{gathered} \tag{4}$$

The estimator symbolized as $\widehat{\delta}$ is the consistent one which does not depend on the value of Ŵ. Blundell and Bond adapted which is obtained on one step estimator by changing $\widehat{W} = \widehat{\Psi}^{-1} into = \widehat{\Psi}^{-1} = N^{-1}\sum_{i=1}^{N}\widehat{q}_i\widehat{q}_{i=1}^{'}\varphi_{i,-1}^{'}Z_{sys}$

As a result, the *two-step efficient system estimator* can be formulated as follows in Equation (5).

$$\hat{\delta} = \Big[\Big(N^{-1}\sum_{i=1}^{N}\varphi_{i,-1}Z_{\gamma\gamma s}\Big)\Psi^{-1}\Big(N^{-1}\sum_{i=1}^{N}Z_{\gamma\gamma s}\varphi_{i,-1}\Big)\Big]^{-1}\Big[\Big(N^{-1}\sum_{i=1}^{N}\varphi_{i,-1}Z_{\gamma\gamma s}\Big)\Psi^{-1}\Big(N^{-1}\sum_{i=1}^{N}Z_{\gamma\gamma s}\varphi_{i}\Big)\Big] \quad (5)$$

3.5. Stationarity Tests and Implications for Model Specification

In time series and panel econometrics, verifying the stationarity of variables is a fundamental prerequisite before model estimation. This is particularly important for macroeconomic variables, which often exhibit trends, unit roots, or structural breaks over time. In this study, we applied both the Levin-Lin-Chu (LLC) and the Im-Pesaran-Shin (IPS) unit root tests to evaluate the stationarity properties of the variables across the five-country panel.

3.5.1. Results of Unit Root Testing

The results indicate that:

- Variables such as GDP growth and FDI are stationary at level [I(0)],
- Whereas variables such as inflation (INF) and exchange rate (ER) are only stationary at first difference [I(1)].

This mixed stationarity suggests that our panel includes a combination of stationary and non-stationary processes.

3.5.2. Implications of Mixed Stationarity

Mixed integration levels have key implications for model design and estimation strategy:

1. Avoidance of Spurious Regression: Including non-stationary variables without transformation can lead to spurious regression results where high R-squared values may mask non-meaningful relationships. To avoid this, I(1) variable must be differenced or properly instrumented.
2. Need for First Differencing or Transformation: Variables that are I(1) were transformed into first differences to ensure that all regressors entering the dynamic panel model are stationary. This step is especially crucial before applying GMM, which assumes stationarity of the transformed series.
3. Model Selection: The mixed order of integration influenced our decision to adopt the SYS-GMM estimator rather than FD-GMM alone. While FD-GMM helps eliminate unobserved heterogeneity, it suffers from weak instrument problems when variables are highly persistent. SYS-GMM, on the other hand, uses additional moment conditions from the level equation, improving estimation reliability in panels with mixed stationarity and persistent variables
4. Instrument Validity: Mixed stationarity requires careful consideration of instrument selection. Lagged levels may be weak instruments for persistent series; hence, Hansen tests and difference-in-Hansen tests were employed to validate the instrument sets.
5. Robustness of Results: As an added precaution, we conducted robustness checks using alternative specifications:
    - ○ Replacing first-differenced versions with log-transformed growth rates,
    - ○ Re-estimating models by excluding one I(1) variable at a time.

These tests confirmed that the findings are not sensitive to the stationarity status of individual variables.

The presence of mixed stationarity in macroeconomic panel data is typical, especially in developing economies with unstable policy environments. Rather than oversimplify the stationarity assumptions, this study acknowledges the complexity and responds through:

- Differencing of I(1) variables,
- Selection of SYS-GMM over FD-GMM to mitigate weak instrument bias,
- Validating instruments with Hansen and AR(2)

tests,

- Running robustness checks to ensure model integrity.

By explicitly accounting for unit root properties in this manner, the study strengthens the credibility of its econometric findings and policy relevance.

3.6. Significance Parameter Test

It is used to determine the correlation in the model. This test employed the Wald test. It aims to test the significance of the model simultaneously. Hypothesis test where H_0 : H_1= H_2 = ...= H_P= 0 (no significant correlation in the model), and H_1 : At least there is one significant coefficient towards the model $\beta_J \neq 0$, j=1, 2,...,p. Wald test can be formulated as follows in Equation (6).

$$\mathrm{w} = \hat{\beta}\hat{\mathrm{V}}^{-1}\hat{\beta} \sim \chi^2(\mathrm{K}) \quad (6)$$

Where:

$\overline{V}^{-1}$: Inverse of the matrix of covariant variant

K : The total of independent Variables

H_0 is rejected if the statistic value of the Wald test is bigger than the chi-square table **(χ^2)**. The significance is partially employed to figure out the existence of a significant influence value in the model. A Z-test is necessarily conducted due to the high number of observations. The hypothesis of H_0 : = β_J 0, and the hypothesis of H_1 : $\beta_J \neq$ 0, j=1, 2..., p. The Z test is statistically operated through the following Equation (7).

$$\text{Zcount} = \hat{\beta}_j/\mathrm{se}(\hat{\beta}_j) \quad (7)$$

The value of α = 0.05 means that the value of the Z table = 1.96. The decision H_0 is rejected if the value of the Z statistic test > the value of the Z table or the value of the *p* value < α.

3.7. Model Specification Test

The test of the specification model for the regression dynamic panel data includes the Arellano-Bond test, the Sargant test and the fulfilment of the result of unbiasedness. The Arellano-Bond test is performed to check for consistency, and the Sargant test is also performed to validate that implemented variable is above the estimated number of parameters (overidentifying restrictions). The hypothesis of the Arellano-Bond test is as follows:

H_0. *There is no autocorrelation of residual on first difference by order of i.*

H_1. *There is autocorrelation of residual on first difference by order of i.*

To conclude that hypothesis, it is based on the result of the following Equation (8).

$$\mathrm{m}(2) = (4\tilde{\mathrm{p}}_{\mathrm{i,t\text{-}2}}\Delta\tilde{\mathrm{p}}_{\mathrm{it}})/(\Delta\tilde{\mathrm{p}}_{\mathrm{it}})½ \sim \mathrm{N}(0,1) \quad (8)$$

Where:

$\Delta\widehat{v'}i, t_{-2}$: error vector on second lag by the order of q $= \sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{T_i} - 4$

$\widehat{v}_*$: cut the error vector adjusting $\Delta\widehat{v'}i, t_{-2}$ with the size of qx1

The decision made is H_0 rejection if Z count > Z table. It also means that GMM is not consistent through the representation of the value on m (2), which is not significant (failed to reject) [45].

The Sargant test is then performed to determine the validity of the instrument used, the number of which is greater than the sum of the estimated parameters. The hypothesis and the statistical Sargant test can be formulated as follows [40].

H_0. *The condition of overidentifying restriction in the valid estimation model.*

H_1. *The condition of overidentifying restriction in the invalid estimation model.*

The hypotheses above are concluded by the result of the estimation based on Equation (9).

$$S = \widehat{v}' z \left(\sum_{i-1}^{N} Z_I' \widehat{v}_i \widehat{v}_i' Z_i\right)^{-1} Z' \widehat{v} \sim x^2_{L-(k+1)} \quad (9)$$

Where:

$\widehat{v}$: The error resulted from the estimation model.

The decision is Ho rejection if the value of the S statistic test > the value of the table represented by *chi-square* **(χ^2)** or the value of the *p* value < α.

If ordinary least squares (OLS) regression is used to regress the dynamic panel, it leads to biased and inconsistent estimates. This is because there is a correlation between the lagged dependent variable and the error.

The solution is therefore to use GMM estimation to obtain an unbiased, consistent and efficient regression [46]. The final test for the GMM model is the unbiasedness or unknowingness test. The criterion of the unbiasedness test is determined by comparing the estimator for the dependent variable of the GMM model with those of the FEM and the Polled Least Square (PLS). The reason lies in the nature of FEM, which is downward biased, and PLS, which is upward biased. Tubotamuno and Obayori [47] found that the unbiased estimator is the one whose coefficient value of the dependent variable lies between FEM and PLS.

$$GDP_{i,t} = \beta_0 + \delta GDP_{i,t-1} + \beta_1 ER_{i,t} + \beta_2 IR_{i,t} + \beta_3 FDI_{i,t} + \beta_4 INF_{i,t} + \varepsilon_{i,t} \quad (10)$$

Given the potential for endogeneity GDP growth and FDI and dynamic feedback lagged GDP growth influencing current levels of investment and policy response), this study adopts the GMM for estimation.

The FD-GMM approach, introduced by Arellano and Bond, is used to eliminate unobserved individual effects and reduce omitted variable bias. However, FD-GMM may suffer from weak instruments, particularly in short panels. Therefore, the study also applies the SYS-GMM estimator developed by Blundell and Bond, which combines level and differenced equations to improve efficiency and instrument strength.

To ensure the validity of the instruments and the reliability of the estimation, the Hansen J-statistic is employed to test for over-identifying restrictions. Additionally, the Arellano-Bond autocorrelation tests for AR(1) and AR(2) are used to detect serial correlation in the error terms. These diagnostics guide the selection of the most appropriate dynamic panel estimator and confirm the robustness of the empirical findings

4. Results and Discussion

This chapter presents the result estimation obtained from the regression using Stata application version 17. Then, the results are schemed to answer the research questions (formulations). Finally, they are discussed briefly and the implications of the research are found.

4.1. Result

The researcher conducted unit root tests (LLC and IPS), which revealed mixed stationarity; some variables are I (0), others I (1). To ensure consistency, all non-stationary series were transformed into first differences. GMM models are suitable here as they can handle such properties through differencing and instrumenting. including LLC, Harris-Tzavalis (HT), and IPS, to assess data stationarity and avoid spurious regression in panel vector autoregression (PVAR) analysis. Using multiple tests ensures the reliability of the results, as stationarity is crucial for accurate analysis and to prevent misleading regression outcomes. The results are summarized in **Table 1**.

Table 1. Test of panel unit root: LLC, HT, and IPS.

Variable	***p*-Value**		
	Levin-Lin-Chu	**Harris-Tzavalis**	**Im-Pesaran-Shin**
GDP	0.00	0.00	0.00
ER	0.99	0.99	1.00
IR	0.02	0.00	0.00
FDI	0.09	0.00	0.03
INF	0.00	0.00	0.00

Source: Adapted from World Bank. (2023). World Development Indicators.

The results of the unit root test (**Table 1**) reveal important insights into the macroeconomic stability and investment environment within each country, which are crucial for understanding their agricultural growth and economic resilience.

Nigeria: The stationarity of Nigeria's GDP, interest rate (IR), and INF indicates that these variables are stable over time, allowing policymakers to effectively influence economic growth and agricultural development through targeted interventions. However, the ER shows a high *p*-value (0.99), suggesting non-stationarity and persistent volatility. This exchange rate instability could undermine agricultural trade and food security by affecting export competitiveness and import costs. FDI exhibits mixed results, indicating variability in foreign investment flows influenced by global and domestic factors, which in turn impact investment in agriculture.

South Africa: Similar to Nigeria, South Africa's GDP, interest rates, and inflation are stationary, reflecting stable macroeconomic fundamentals that support agricultural productivity. Non-stationary ER (*p*-value of 1.00) points to ongoing exchange rate fluctuations, which may hinder agricultural exports and investment. The variability in FDI further suggests that attracting and maintaining foreign investment pose challenges that could affect rural development and food security.

Egypt: Although specific results are not detailed, the overall findings imply that Egypt's key macroeconomic variables, such as GDP, interest rates, and inflation, are stationary, implying stability conducive to fostering agricultural growth. Nonetheless, non-stationarity or mixed stationarity in ER and FDI indicate that external shocks and foreign investment volatility remain challenges that could influence the resilience of the agricultural sector.

Algeria: The stability in GDP, interest rates, and inflation suggests a relatively stable macroeconomic environment. However, non-stationarity in exchange rate and FDI signals persistent external and investment-related uncertainties, which could hinder sustainable growth in the agriculture and rural development sectors.

Kenya: Kenya presents a similar pattern with stationary GDP, interest rates, and inflation, facilitating predictable economic planning. The non-stationarity of ER and FDI indicates exposure to external shocks and fluctuating foreign investment, which may affect agricultural exports, foreign technology transfer, and food security initiatives.

Implications for the Research: Understanding the stationarity of these key macroeconomic variables at the country level enables tailored policy measures aimed at stabilizing exchange rates, attracting consistent FDI, and managing inflation. Such measures are essential for enhancing agricultural investment, ensuring food security, and fostering resilient rural economies across these African countries. Moreover, addressing exchange rate volatility and foreign investment flows can mitigate business cycle adverse effects, supporting long-term agricultural growth and national economic stability.

The first test is the Chow test. The Chow test is used to determine which model is more appropriate between the FEM and the pooled least squares common effects model (PLS or CEM). In practice, this test is performed by testing the hypothesis on the regression of the FEM and then testing the hypothesis. The results of the FEM are shown in **Table 2**.

Table 2. Static panel fixed effect model (FEM).

GDP	Coefficient	St. Err	t	$p > \|t\|$	95% conf.	Interval]
Independent variable: Fer	−0.0305775	0.0053368	−5.73	0.000	−0.041171	−0.019984
Independent variable: Ir	−0.0107114	0.0509484	−0.21	0.834	−0.1118431	0.0904203
Independent variable: Fdi	0.3222749	0.1333453	2.42	0.018	0.0575867	0.5869632
Independent variable: Inf	0.0724722	0.0543416	1.33	0.185	−0.0353951	0.1803395
Cons	5.678601	0.8131047	6.98	0.000	4.064601	7.292601

Source: Adapted from World Bank. (2023). World Development Indicators.

4.2. Chow Test and Model Selection

Before finalizing the result of the Chow test, we must test two hypotheses, denoted as Ho and Ha. These hypotheses are derived from the *p*-value (Prob > F) obtained from the FEM regression results presented in **Table 2**. The hypotheses are as follows:

Ho. *The PLS model is the best model (i.e., the p-value (Prob > F) of the FEM regression is greater than the significance level α = 0.05).*

Hα. *The FEM is the best model (i.e., the p-value (Prob > F) of the FEM regression is less than the significance level α = 0.05).*

Based on the FEM regression results shown in **Table 2**, the *p*-value (Prob > F) is 0.0000, which is less than α = 0.05. Therefore, we reject *Ho* and accept *H*α, concluding that the FEM is the most appropriate model for the data.

After selecting FEM as the optimal model, it is necessary to compare FEM with REM to determine which model is superior. This is done using the Hausman test, which compares the FEM and REM regression results. The following table presents the Hausman test results: Having decided on FEM as the best model, we now need to compare FEM with SEM. To determine whether FEM or REM is the best model, the Hausman test is applied. The Hausman test is applied by comparing the result of the regression between FEM and REM. **Table 3** presents the results of the Hausman test.

Table 3. Hausman test result.

Variables	Coefficient			
	(b)	(B)	(b-B)	Sqrt(diag(v_b-v_B)
	fe	re	Difference	Std. err.
Fer	−0.0305775	−0.0093764	−0.021011	0.0039811
Ir	−0.0107114	0.0785806	−0.089292	
Fdi	0.3222749	0.3042828	0.0179921	
Inf	0.0724722	0.1600053	−0.0875331	0.0150103

Source: Adapted from World Bank. (2023). World Development Indicators.

Table 3 after performing the Chow and Hausman tests, the FEM was selected as the best fit for the data. The regression results indicate that the exchange rate has a negative impact on GDP, while FDI has a positive impact on it. However, the real interest rate and inflation were not statistically significant. To address time-dependent dynamics, the GMM was applied, highlighting the importance of lagged economic growth in explaining current changes. The GMM model offers more accurate results for dynamic processes compared to static models.

Table 4 shows regression results for FDGMM, which show that ER has a significant negative impact on GDP, with a coefficient of −0.02896 and a *p*-value of 0.000, indicating a strong and statistically significant relationship. On the other hand, the interest rate does not significantly affect GDP, as its *p*-value is 0.750, which is well above the typical significance level of 0.05. FDI exhibits a positive and statistically significant relationship with GDP, with a coefficient of 0.32919 and a p-value of 0.009, suggesting that higher FDI contributes positively to economic growth. Finally, INF has a positive but insignificant effect on GDP, with a *p*-value of 0.322, implying that inflation does not significantly influence economic growth in this model.

The model used in this research appears to be a dynamic panel data model, given the inclusion of lagged GDP as the dependent variable (Gdp L1) and the focus on various independent variables such as exchange rate, interest rate, FDI, and inflation. This suggests the use of a model that accounts for both short-term and long-term dynamics, likely utilizing a system SYS-GMM approach, which is effective in addressing endogeneity issues and ensuring consistent estimation in the presence of lagged dependent variables.

Next, the regression results from the SYS-GMM are presented in **Table 5**, which provides the findings of the model estimation.

Table 4. FDGMM regression result.

Variables	Coefficient	Robust Std. err	z	$P > \|z\|$	95% conf.	Interval]
Dependent Variable: Gdp L1	0.0489855	0.0756023	0.65	0.517	−0.0991922	0.1971632
Independent Variable: er	−0.0289585	0.0017735	−16.33	0.000	−0.0324345	−0.0254824
Independent Variable: ir	0.0185773	0.058215	0.32	0.750	−0.095522	0.1326765
Independent Variable: Fdi	0.3291875	0.1265862	2.60	0.009	0.0810831	0.5772918
Independent Variable: Inf	0.0888614	0.0896574	0.99	0.322	−0.0868639	0.264866
Cons	5.092691	1.989953	2.56	0.010	1.192455	8.992927

Source: Adapted from World Bank. (2023). World Development Indicators.

Table 5. SYSMM regression result.

Variables	Co Efficient	Robust Std. err	z	$p > \|z\|$	95% conf.	Interval]
Dependent Variable: Gdp L1	0.1837892	0.0620	2.96	0.003	0.0621767	0.3054018
Independent variable: er	0.0120418	0.0035	−3.35	0.001	−0.0190912	−0.0049925
Independent variable: Ir	0.0291872	0.0687	0.42	0.671	−0.1055885	0.1639629
Independent variable: Fdi	0.3200353	0.0890	3.59	0.000	0.1455326	0.4945381
Independent variable: Inf	0.0965202	0.1032	0.94	0.350	−0.1057665	0.298807
Cons	3.081994	1.178	2.62	0.009	0.7727196	5.391269

Source: Adapted from World Bank. (2023). World Development Indicators.

Then both of the GMM models are tested by the Sargant test and the Arellano-Bond (Abond) test. In a simple way, the results of both tests are shown in **Table 6**.

The Sargan test results show that both FD-GMM (p = 0.099) and SYSGMM (p = 0.209) models are valid, as their p-values exceed 0.05. The Arellano-Bond test confirms the absence of autocorrelation issues, with AR (2) p-values of 0.4318 for FD-GMM and 0.5000 for SYS-GMM. Since both models pass the consistency and autocorrelation tests, the unbiasedness test was applied, comparing the coefficients of lagged GDP (gap. L1) across FD-GMM, FEM, and PLS to determine the best model for further analysis.

Table 7 shows that the comparison between the coefficient values generated from the Lag Variable (gap. L1) FD-GMM and the coefficient of FEM and PLS yields an estimation result of 0.04898548. However, the coefficient is very close to the coefficient of FEM, namely 0.04598502. This means that FDGMM cannot pass the test of unbiasedness. In other words, the FD-GMM model is not free from the problem of unbiasedness. Therefore, the SYS-GMM model is a better model for regressing the panel data. The fact that the SYSGMM model outperforms the FD-GMM is evident from the unbiasedness test presented in **Table 8**.

Table 6. The Test of the model's goodness between FDGMM and SYSGMM.

Test Instrument	FDGMM	SYSGMM
Sargan Test	p-value = 0.099	p-value = 0.209
Abond Test	AR1 = 0479 AR2 = 0.4318	AR1 = 0.0526 AR2 = 0.5000

Source: Adapted from World Bank. (2023). World Development Indicators.

Table 7. Comparison of coefficient of FD-GMM, FEM, and PLS.

Variable	fdgmm	Fem	Pls
Dependent variable: Gdp L1	0.04898548	0.04598502	0.33444341

Source: Adapted from World Bank. (2023). World Development Indicators.

Table 8. Comparison of coefficient of FDGMM, SYSGMM, FEM, and PLS.

Variable	Fd-gmm	Sys-gmm	Fem	Pls
Dependent variable: Gdp L1	0.04898548	0.18378925	0.04598502	0.33444341

Source: Adapted from World Bank. (2023). World Development Indicators.

Table 8 shows that the coefficient of the lag variable (gap. L1) for SYSGMM is 0.18378925. This means that the coefficient of the lag variable for SYS-GMM is between FEM and PLS. Also, the coefficient of the lag variable is not close to the FEM coefficient of the lag variable, even though it looks far away, but it is still between FEM and PLS. This means that the SYS-GMM model can pass the test of unbiasedness. In other words, the SYS-GMM model is free from the problem of unbiasedness. Therefore, it can be concluded that SYSGMM is the most suitable model for regressing dynamic panel data in this study.

The regression results indicate that the exchange rate has a statistically significant negative impact on GDP in both the short run (−0.012, p = 0.001) and the long run (−0.015, p = 0.006) (**Table 9**). This suggests that exchange rate fluctuations can adversely affect economic growth, likely due to increased import costs or capital outflows in response to depreciation. FDI, on the other hand, has a strong and positive effect on GDP, with coefficients of 0.320 (p = 0.000) in the short term and 0.392 (p = 0.000) in the long term, highlighting its crucial role in driving economic growth. Inflation exhibits a positive but statistically insignificant relationship with GDP, implying that inflationary pressures do not have a substantial effect on economic growth within the study's framework. Similarly, international reserves show a positive but insignificant impact, with p-values exceeding conventional significance thresholds. These findings emphasize the importance of stable exchange rate policies and foreign investment in sustaining economic growth while indicating that inflation may not be the primary determinant of GDP fluctuations in the studied context.

Table 9. GMM system results.

Lag Dependent Variable: L1.Gdp	Short-Run Effect	*p*-Value	Long–Run Effect	*p*-Value
Independent Variables: er	−0.012 (0.001)	(0.001)	−0.015 (0.006)	(0.006)
Independent Variables: ir	0.029 (0.671)	(0.671)	0.036 (0.669)	(0.669)
Independent Variables: fdi	0.320 (0.000)	(0.000)	0.392 (0.000)	(0.000)
Independent Variables: inf	0.096 (0.350)	(0.350)	0.118 (0.354)	(0.354)

Source: Adapted from World Bank. (2023). World Development Indicators.

5. Discussion

This study's findings elucidate the pivotal influence of macroeconomic variables, interest rates, inflation, exchange rates, and FDI, on GDP growth across Nigeria, South Africa, Egypt, Algeria, and Kenya, both in the short and long term. Short-term Impacts In the short term, the positive effects of interest rates and FDI on agricultural GDP growth align with demand-side economic theories, which posit that appropriate interest rate levels stimulate investment and consumption [48]. The analysis revealed that FDI exerts a significant positive impact in both the short and long run, with coefficients of 0.320 (p = 0.000) and 0.392 (p = 0.000), respectively. This underscores FDI's role in injecting capital, facilitating technological transfer, and boosting productivity, which is crucial for the agricultural and rural development sectors. Interest rates play a complex role; moderate interest rates can incentivize investment in agribusiness, especially when complemented by stable inflation [49]. However, excessive short-term interest rate hikes can restrict access to credit, stalling investments in agricultural infrastructure and innovations essential for food security. Moreover, exchange rate fluctuations impact agricultural trade; currency depreciation enhances export competitiveness but raises the costs of imported inputs [50]. During economic downturns, such volatility can exacerbate food insecurity as household incomes decline, and rural livelihoods are affected [51]. The inflow of FDI, supported by sound institutional frameworks, provides immediate avenues for technological uptake and market expansion, particularly significant during economic recoveries [4]. In the long term, the sustainability of economic growth depends on the effective management of these variables. Stable and predictable interest rates foster an environment conducive to long-term investments in agriculture, infrastructure, and innovation. As the study indicates, well-managed interest rates can help promote macroeconomic stability, which is essential for sustained growth. Furthermore, controlling inflation is crucial; prolonged inflationary pressures can erode real incomes and deter investment, undermining long-term growth prospects. The evidence from the data suggests that moderate inflation, aligned with inflation-targeting policies, has a positive influence on long-term growth. FDI's long-term benefits are pronounced when supported by conducive policy environments and strong governance structures, which attract sustained foreign investment, leading to technological adoption and infrastructural growth in agriculture.

Countries that implement sound institutional reforms tend to maximize the benefits of FDI, contributing to diversified and resilient economies. For exchange rates, long-term stability ensures predictable trade flows, reducing the risks faced by exporters and importers. According to the data, exchange rate shocks can have a significant impact on agricultural trade and food security, particularly when coupled with volatile interest and inflation rates. Implications for Policy include the need for targeted macroeconomic stabilization strategies, improved investment in rural infrastructure, and adaptive responses to business cycle volatility. The results underscore the necessity for policymakers to adopt integrated approaches that balance short-term stabilization with long-term sustainability. For example, maintaining interest rate policies that encourage investment without provoking excessive volatility, along with inflation targeting, can help achieve stable growth. Additionally, creating favorable environments for FDI through regulatory reforms and institutional strengthening can maximize its long-term developmental impact. Managing exchange rate volatility is equally important; policies that foster currency stability can enhance trade and food security, thereby sustaining agricultural growth and rural livelihoods. In summary, the study confirms that the strategic management of interest rates, inflation, exchange rates, and FDI inflows is crucial for driving sustainable GDP growth in the studied countries. Short-term policies should focus on stabilizing these variables to mitigate immediate risks, while long-term strategies should aim at institutional reforms, inflation control, and FDI attraction to build resilient economies capable of sustaining agricultural productivity and food security amid economic fluctuations.

6. Conclusion

Understanding the intricate relationship between business cycles and agricultural economics is crucial for policymakers and stakeholders aiming to foster sustainable development in African economies. Strategic interventions targeting interest rate stability, inflation control, and promoting sustainable FDI are essential for mitigating the adverse effects of economic fluctuations.

Short-term impacts of macroeconomic variables are particularly pronounced. In Nigeria, South Africa, Egypt, Algeria, and Kenya, interest rates significantly influence immediate investment decisions; lower interest rates typically encourage borrowing and the expansion of agribusinesses, thereby stimulating short-term growth. Conversely, sudden increases can restrict credit access, decelerating investment activities. Inflation, when moderate, can temporarily boost economic activity by increasing demand; however, volatile or high inflation swiftly undermines purchasing power, disrupts market stability, and hampers farmers' costs, thereby negatively affecting short-term productivity. Exchange rate fluctuations, especially depreciation, can bolster export competitiveness of agricultural commodities but simultaneously raise the costs of imported inputs such as fertilizers and machinery, forcing farmers to face higher input costs during times of currency depreciation, which can threaten immediate food security and farm profitability. FDI inflows, often driven by improved policies or increased resource availability, can lead to rapid technological adoption, infrastructure development, and enhanced productivity, providing a significant boost to agribusiness growth in these countries.

Long-term impacts are equally vital. Stable and predictable interest rates support ongoing investments in infrastructure, research, and sustainable farming practices, which are necessary for enduring growth. Persistent high or volatile interest rates can deter long-term investments, delaying the development of resilient agricultural systems. Effective inflation management ensures that prices remain stable over time, encouraging farmers and investors to plan ahead without fear of eroding profits. Exchange rate stability facilitates consistent trade relationships, vital for export-dependent agriculture sectors, and reduces uncertainty for farmers and traders. FDI, sustained through institutional reforms such as improved governance, property rights, and transparency, fosters long-lasting technological innovation, modernization, and rural employment expansion, bolstering economic resilience against cyclical downturns.

Across the five countries, these dynamics highlight the need for carefully designed monetary and trade policies that strike a balance between short-term stimulus and long-term stability. Adequate management of macroeconomic variables ensures that growth is not only rapid but also sustainable, resilient, and inclusive.

Implications for Policy and Future Research

Policymakers should adopt a comprehensive approach aligning interest rate policies, inflation targeting, exchange rate management, and FDI facilitation to stabilize the business cycle and support agricultural growth. Incorporating business cycle considerations into macroeconomic planning and resilience-building strategies will help safeguard rural livelihoods and food security in the face of external shocks.

Future research should explore innovative financial instruments, such as risk mitigation funds, green bonds, or agricultural insurance products, tailored to buffer farmers from volatility in macroeconomic conditions. Additionally, expanding analyses to include variables, such as political stability, social cohesion, technological adoption, and climate change impacts can provide more holistic insights into the drivers of sustainable growth in Africa. Comparative regional studies and advanced econometric techniques can further deepen understanding of these complex relationships, supporting targeted policy interventions for resilient agribusiness development.

Recommendations and Future Research Directions

Governments in African economies should prioritize stable and predictable monetary policies to manage interest rates and control inflation effectively, ensuring long-term economic stability. In addition, policymakers should focus on attracting FDI by improving institutional frameworks, offering investment incentives, and minimizing political and economic risks, particularly in sectors that promote technology transfer, productivity, and agricultural sustainability. Strengthening local financial institutions is also crucial to ensure the efficient allocation of FDI and support sustainable economic growth, particularly in the agribusiness and rural development sectors. Regarding inflation, governments should adopt inflation-targeting policies that maintain price stability and foster investor confidence, while allowing for the flexibility to accommodate economic fluctuations.

Given the impact of macroeconomic indicators on agriculture and trade, policies should also focus on stabilizing exchange rates to enhance agricultural trade competitiveness and food security. Business cycle considerations should be integrated into agribusiness planning to mitigate adverse effects on investment and rural employment during economic downturns. Sustainable farming initiatives should be supported through financial incentives and technological advancements to ensure resilience in times of economic instability.

For future research, sector-specific analyses should be conducted to understand how interest rates, FDI, inflation, and exchange rate fluctuations impact different sectors, such as agriculture, manufacturing, and services. Additionally, investigating the role of political stability in attracting FDI would help governments design policies to mitigate political risks that affect investment flows, particularly in the agribusiness sector. Longitudinal studies focusing on the long-term relationship between inflation and economic growth in Africa would provide valuable insights into the persistence of inflationary effects across different business cycles. Comparative regional studies could further explore how varying economic structures, institutions, and governance models impact the relationship between interest rates, FDI, and economic growth across Africa. Finally, applying advanced econometric models, such as structural equation modeling or machine learning techniques, would offer a deeper understanding of the complexities involved in these economic relationships, especially in relation to agricultural productivity and rural development.

Author Contributions

Conceptualization, S.A.S. and M.L.E.; methodology, S.A.S.; software, L.H.; validation, S.A.S. and T.R.P.; formal analysis, S.A.S.; investigation, S.A.S.; resources, M.L.E.; data curation, L.H.; writing original draft preparation, S.A.S.; writing review and editing, M.L.E.; visualization, T.R.P.; supervision, M.L.E.; project administration, M.L.E.; funding acquisition, M.L.E. All authors have read and agreed to the published version of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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