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Agricultural Development as a Driver of Economic Growth in Selected African Countries

Cajetan C. Anuforo[1], Gozie John Achebe[1], & Kenechukwu K. Ede[2]

[1]*Department of Economics and Development Studies, University on the Niger, Umunya, Anambra State, Nigeria.*

[2]*Department of Economics, Godfrey Okoye University, Nike, Enugu.*

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Abstract

The current investigation empirically assesses the dynamic interplay between agrarian progress and economic prosperity within a quartet of selected African nations. Utilizing the Panel Autoregressive Distributed Lag (ARDL) framework pioneered by Pesaran et al. (2001), the research analyzes annual statistical data spanning from 1970 to 2018. To quantify agricultural advancement, the study utilizes the ratio of employment in agriculture (EIAG) alongside agricultural value added (AVD), while relying on real GDP per capita (GDPpc) to measure overall economic expansion. The initial analytical phase verifies the presence of a persistent long-term equilibrium among these core variables before evaluating how incorporating control parameters—and their subsequent interplay with farming indicators—impacts macroeconomic health. Additionally, the research explores causal directions and the unique, country-specific ramifications of both EIAG and AVD on per capita income.

Findings from the Pedroni (1999, 2004) panel cointegration assessments decisively reject the null hypothesis assuming zero cointegration, thereby substantiating a durable long-run synergy linking agrarian maturity to financial growth. Corroborating this outcome, the Panel ARDL projections confirm a statistically profound long-term nexus, with a significantly negative error correction term (ECT) verifying Granger causality and illustrating the system's capacity to recalibrate toward equilibrium following temporary disruptions. Furthermore, interactive variables connected to agrarian metrics demonstrably steer economic momentum, albeit with diminished intensity compared to baseline models omitting these interaction terms. Crucially, the causality evaluation exposes a bidirectional relationship linking AVD to GDPpc, whereas agricultural workforce participation exerts a unidirectional Granger causality upon GDPpc. Country-level bounds testing likewise dismisses the no-cointegration null hypothesis across all four territories. Finally, the negative and statistically valid one-period lagged ECT coefficients solidify the reality of long-term equilibria within the localized contexts of each state, confirming that farming sector enhancement remains a pivotal catalyst for economic progress, even as its exact magnitude and causal nature fluctuate depending on the specific metric and sovereign environment.

Keywords: Agrarian Advancement, Macroeconomic Expansion, Panel ARDL Framework.

Introduction

Historically, the evolution of the farming sector and its consequent impact on financial performance have dominated policy discourse across the African continent. Given Africa's immense reserves of cultivable terrain and untapped cultivation potential, agriculture is increasingly recognized as the cornerstone of the region's future prosperity. Beyond mere crop cultivation and animal husbandry, advancing this sector represents a critical mechanism for generating jobs—especially for a rapidly expanding youth demographic—while simultaneously bolstering food security and catalyzing wider structural economic transformations. Foundational economic theories posited by Lewis (1954), Hirschman (1958), and Jorgenson (1961) similarly illustrate how agrarian maturation can invigorate adjacent industries and propel systemic economic overhauls. Sustaining such momentum, however, demands rigorous policy adjustments designed to forge tighter integrations between farming outputs and industrial applications. Rather than perpetually exporting raw commodities, African administrations are urged to incentivize the localized processing of goods like cocoa, cotton, latex, timber, wool, and leather, thereby channeling these resources as foundational inputs for domestic manufacturing operations. Elevating these agro-industrial linkages holds the promise of multiplying employment avenues, augmenting household revenues, and ensuring robust food networks continent-wide.

Despite its undeniable strategic value, African agriculture remains largely entrenched in traditional, smallholder methodologies. This structural bottleneck has severely capped the industry’s contribution to overall gross domestic product (GDP), a problem exacerbated by productivity levels that have essentially flatlined since the 1980s. Consequently, multiple regions have suffered localized declines in both harvest volumes and agricultural value additions. The chronic marginalization of rural agrarian enterprise, combined with the relentless migration of farming families toward metropolitan centers seeking improved prospects, has triggered a steady demographic drain in rural territories. Consequently, this exodus diminishes the appeal of agribusiness investments, severely escalating food scarcity within the very communities tasked with producing it. Because many rural households fail to yield adequate sustenance for their own immediate consumption, dependency on external food markets has surged; current data suggests over half of these families routinely purchase provisions to offset their production shortfalls. These hurdles are further magnified by systemic deficits: archaic farming implements, sparse irrigation networks, the compounding detriments of greenhouse gas emissions, inequitable land access, scarce fertilizers, exorbitant credit rates, depressed per capita revenues, and erratic commodity pricing. Together, these barriers tether extreme poverty and chronic hunger directly to rural livelihoods throughout developing nations. Emphasizing the gravity of these limitations, the Economic Commission for Africa (2004, 2007) highlighted the severe welfare consequences of depressed agricultural output, noting that nearly 80% of the continent’s inhabitants rely heavily on this sector for survival.

Simultaneously, relentless urban expansion and sustained population surges within rural zones have exerted massive pressure on available agricultural acreage and physical resources. While Africa's cultivated footprint expanded by roughly 70% over the last thirty years, corresponding annual yields

climbed by a mere 32%, and individual worker productivity saw only a marginal 1.8% increase. Though these figures denote incremental progress, total continental output remains woefully inadequate to satisfy escalating commodity demands or to keep pace with global agricultural advancements. Furthermore, systemic threats such as ecological degradation, volatile climate shifts, deficient state assistance, precarious market structures, and hostile commercial climates threaten to strangle future sectoral investments. These enduring obstacles highlight an urgent mandate: authorities must supercharge farming efficiency, upgrade rural logistical frameworks, and engineer a supportive legislative atmosphere to fully weaponize agriculture as a premier engine of economic growth.

Acknowledging agriculture's paramount role in poverty eradication and wealth generation, various institutional frameworks have attempted to resolve chronic production and food security deficits. The Department for International Development (DFID), for instance, formulated a policy matrix positioning agriculture as a vital vehicle for actualizing the Sustainable Development Goals (SDGs) in Africa. DFID delineated six critical intervention vectors: amplifying public expenditure, expanding agricultural finance, fostering technological integration, democratizing land access, defending intellectual and property rights, and mitigating structural distortions in global commodity exchanges. Concurrently, the New Partnership for Africa's Development (NEPAD) alongside the Comprehensive Africa Agriculture Development Programme (CAADP) materialized as unified, multilateral campaigns intended to maximize the continent's leverage within global food markets.

Against this backdrop of policy intervention, specific nations were pinpointed as highly lucrative hubs for agricultural capital, with cassava, maize, wheat, rice, soybeans, and groundnuts flagged for their exceptional continental and international market demand. Ethiopia emerged as a prime candidate for wheat cultivation, Nigeria for cassava, and Tanzania for maize, with strong potential also identified in South Africa, Ghana, and Kenya. Due to these targeted initiatives, annual agrarian growth has consistently eclipsed 7% since 2003, propelling several states closer to absolute food security. In Ethiopia, agriculture contributed to an impressive 45% of GDP over the last decade and a half—a metric roughly double the Sub-Saharan African (SSA) median and tenfold the global average. Driven by an estimated 12 million smallholder plots, farming absorbs 85% of the Ethiopian workforce. While teff and maize dominate cultivation, the nation remains the preeminent wheat producer within the SSA territory.

Conversely, the steep plunge in global petroleum and raw material valuations in 2014 severely fractured Nigeria's macroeconomic stability, accelerating aggressive state efforts to pivot the economy toward agro-processing and cultivation. As one of the continent's paramount cassava producers, Nigeria routinely generates yields surpassing 50 million tonnes annually, harvesting roughly 13.6 tonnes per hectare with substantial room for future optimization. Similarly, agriculture forms the backbone of Tanzania's economy, generating about 31% of the national GDP. Blessed with optimal climatic variables for SSA farming, Tanzania exports highly sought-after cash crops—including tea, coffee, cashew nuts, cotton, and tobacco—while maintaining a distinct comparative advantage in maize. With nearly four million hectares dedicated to its cultivation, Tanzania stands as a titan of maize production across Eastern and Southern Africa.

Considering these nuanced realities and the historically fractured empirical data regarding the agriculture-growth nexus, this analysis rigorously interrogates the dynamic linking agrarian

development to economic momentum in selectively chosen African states. Specifically, it probes whether the broader macroeconomic climate interacts with farming indicators to meaningfully alter economic trajectories. The investigation also delineates the precise causal pathways flowing between varying agricultural proxies and GDP performance. Finally, respecting the inherent heterogeneity of these nations—evident in their divergent legislative frameworks, enforcement capabilities, and strategic priorities—the study isolates the idiosyncratic, country-specific impacts of agricultural progression on overall wealth generation.

Brief Overview of Agricultural Development Policies in Africa

A robust, adaptive agricultural apparatus is vital to Africa's socio-economic metamorphosis. Far exceeding its mandate of sheer sustenance, the sector possesses the intrinsic capacity to alleviate destitution, curb inequality, eradicate hunger, stimulate intra-continental commerce, catalyze industrial diversification, and profoundly elevate overarching economic metrics. However, quantifying the precise success of agrarian reform in developing territories—spanning Sub-Saharan Africa, Latin America, and Southeast Asia—remains notoriously complex, primarily because legislative frameworks are subjected to constant sovereign and international revisions. A primary impediment to rigorous assessment is the glaring lack of standardized, cross-border monitoring architectures capable of evaluating intervention outcomes uniformly.

For decades, the agricultural sphere suffered from acute marginalization by both national authorities and international development coalitions. Consequently, the industry languished in a state of chronic undercapitalization, even within robust farming economies like Kenya and Ethiopia. It wasn't until the twilight of the 1990s that global partners and state governments instituted dedicated protocols to arrest this decline. Unfortunately, these remedial actions immediately collided with profound institutional roadblocks. Persistent capital deficits stifled productive ceilings, while the sector simultaneously floundered in adapting to modern cooperative development paradigms. For instance, the Paris Declaration—which sought to pivot foreign aid away from fragmented, localized projects toward harmonized, state-owned sector-wide poverty eradication frameworks—failed to manifest its anticipated outcomes. This failure largely stemmed from the monumental difficulty of formulating cohesive, sector-wide programs while simultaneously championing localized agrarian interests within insular national policy corridors. The sheer logistical complexity of agriculture, encompassing convoluted supply chains, geographic decentralization, and diverse stakeholder motivations, partially explains these implementation gridlocks. Nonetheless, meticulously engineered blueprints remain mandatory for securing enduring external investment and multilateral backing.

Perceiving agriculture's undeniable influence on poverty reduction, the New Partnership for Africa's Development (NEPAD)—inaugurated in 2001 under the African Union—publicly identified systemic flaws within member states' farming strategies. As a corrective measure, NEPAD launched the Comprehensive Africa Agriculture Development Programme (CAADP), constructing an exclusive, unified framework to modernize agrarian policy across the continent. At its core, CAADP prioritizes ecologically viable farming and systematic poverty dismantling. Concurrently, the African Peer Review Mechanism (APRM) was deployed to elevate broader governance and policy design. Though not strictly an agricultural apparatus, the APRM deeply impacts the sector due to agriculture's outsized economic footprint in SSA nations. The foundational

ethos of NEPAD relies on expansive stakeholder engagement, synchronized regional policymaking, peer-reviewed data-driven legislation, and the aggressive mobilization of private and state capital.

By 2009, the United Nations Food and Agriculture Organization (FAO) introduced the Monitoring and Analysing Food and Agricultural Policies (MAFAP) initiative. MAFAP was engineered to embed sustainable, country-led mechanisms to scrutinize and overhaul farming legislation, targeting inclusive, streamlined growth in low-income territories. Central to this program are the Public Expenditure in Agriculture (PEA) and Price Incentive indices. Because member governments deploy radically different legislative instruments to chase identical macro-level goals, systematic monitoring remains critical. MAFAP datasets illuminate how sovereign wealth is allocated across vital value chains, revealing whether state spending truly aligns with publicized policy objectives. Within this analytical framework, the Nominal Rate of Protection (NRP) serves as a paramount metric for judging how state mandates and market fluctuations manipulate commodity pricing. The NRP effectively gauges both direct state interventions (like price ceilings) and indirect influences (like tariff structures and fluctuating exchange rates).

Further legislative momentum was generated by the 2014 African Union Malabo Declaration (AUMD), which reinvigorated the original CAADP mandates and branded 2014 the "African Year of Agriculture and Food Security". Bound by the AUMD, participatory states pledged to route 10% of their annual national budgets directly into the farming sector. Expanding upon the preceding Maputo Declaration, the Malabo agreement crystallized new operational targets slated for 2025: the total eradication of hunger, a 100% surge in farming productivity, a 50% reduction in post-harvest wastage, and the tripling of cross-border agrarian trade. The agreement also emphasized the necessity of climate-resilient livelihoods that actively dismantle poverty.

Regional Economic Communities (RECs) have equally shouldered the responsibility of championing the CAADP vision by orchestrating localized investment treaties. Following the Malabo accord, rigorous oversight mechanisms were activated, notably the agricultural Joint Sector Reviews (JSRs) steered by the Regional Strategic Analysis and Knowledge Support System (ReSAKSS) and the International Food Policy Research Institute (IFPRI). These reviews ensure administrative transparency and maintain operational momentum through mandatory biennial progress audits initiated in 2017. Ultimately, the modernized CAADP architecture prioritizes addressing systemic operational blockades at sovereign, regional, and continental scales, actively synthesizing the financial commitments initially codified in Maputo—specifically the 10% budget allocation and the target of 6% annual agricultural GDP expansion.

Regional unification is an absolute prerequisite for maximizing cross-border commerce and aggressively defending African economic stakes in the global arena. Given the continent’s historically fragmented trade networks, renewed integration efforts are pivotal. In the Southern and Eastern corridors, the East African Community (EAC), the Southern African Development Community (SADC), and the Common Market for Eastern and Southern Africa (COMESA) have campaigned for a massive tripartite free-trade zone encompassing 26 nations. In Central Africa, organizations like the Central African Economic and Monetary Community (CEMAC) and the Economic Community of Central African States (ECCAS) drive similar agendas, although relentless geopolitical, ethnic, and religious frictions frequently hamstring these coalitions. Conversely, in West Africa, the Economic Community of West African States (ECOWAS) and the

West African Economic and Monetary Union (WAEMU) have successfully championed trade liberalization and uniform external tariffs. Currently, intra-regional exchange captures 10% to 15% of total commerce, predominantly featuring legumes, tubers, cereals, vegetables, and cash crops like rubber and cocoa. Consequently, intensifying regional policy alignment remains essential to forging a lucrative, heavily capitalized farming environment that serves as the vanguard of African economic transformation.

Review of Related Literature

The Physiocrats' Theory of Economic Growth

Originating amid the eighteenth-century Enlightenment, the Physiocratic paradigm was largely championed by French intellectuals such as Anne-Robert-Jacques Turgot and François Quesnay. The foundational doctrine of this school asserts that agriculture is the solitary, irreplaceable fountainhead of national prosperity and sustained growth. According to this framework, systemic economic evolution relies entirely on the expansion of agrarian enterprises, which uniquely produce a "net product" or surplus wealth that cascades through the broader economy. Physiocrats vehemently argued that authentic national riches were measured not by hoarding silver and gold, but by the tangible surplus harvested from the earth.

This theory bestows a singular productive supremacy upon farming, positing that it is the only sector capable of generating output that vastly exceeds its input costs. Physiocratic philosophy segmented society into three distinct strata: the productive tier (tenants and farmers), the proprietors (landowners), and the sterile tier (merchants and artisans). While the productive class single-handedly spawned economic surplus through agricultural labor, the landowners merely dictated resource distribution. The sterile class, despite producing manufactured goods, remained entirely subservient to the agricultural yield for their basic survival. Key tenets of Physiocracy included an unwavering commitment to laissez-faire commerce, private property rights, the concept of diminishing returns, and the paramount necessity of reinvesting working capital.

The Conservation Model of Agricultural Development

Formulated in 1971 by Yujiro Hayami and Vernon Ruttan, the Conservation Model analyzes historical crop management trajectories—notably those of the English Agricultural Revolution—to address the chronic depletion of soil nutrients. The model postulates that agricultural supremacy is achieved by implementing hyper-efficient, labor-intensive cultivation systems, maximizing organic fertilization, and directing capital strictly toward infrastructures that optimize water and land management.

A primary directive of this model is the aggressive conservation of ecological resources without sacrificing yield efficiency. The FAO (2022) defines this approach as a methodology engineered to halt arable land degradation while aggressively restoring compromised soils. Core practices include minimizing mechanical soil disruption, guaranteeing continuous organic soil coverage, and drastically diversifying plant species. These techniques supercharge subterranean biological activity, massively improving nutrient and water retention, thus locking in long-term productivity.

While these tenets are highly adaptable across varied ecological theaters, localized customization remains necessary. The model heavily discourages superfluous tillage and advocates for the microscopic, precise application of agrochemicals and fertilizers to prevent the disruption of natural

biomes. This conservationist paradigm currently serves as the primary intensification vector for global farmers, historically sustaining a reliable 1.0% annual growth in agrarian output. However, this metric notably trails the 3% to 5% demand surge typical of rapidly developing economies. Distinct from theories prioritizing industrial urbanization, the Conservation Model insists that variations in agricultural prosperity are directly tethered to environmental stewardship and ecological conditions.

Empirical Literature

The empirical landscape reveals varied outcomes regarding agricultural development. Bridget et al. (2021) analyzed Nigerian data from 1981 to 2019, confirming that state agricultural expenditure generates a remarkably positive long-term impact on farming productivity. Conversely, Nelson et al. (2023) scrutinized data from 1990 to 2022 using ARDL methodologies and uncovered a negative correlation between agricultural output and public spending, asserting that merely inflating budgets is futile without rigorous resource management. Nelson et al. (2024) further applied FMOLS estimators, discovering a highly significant positive linkage between real GDP (RGDP) and the ratio of farm production to GDP, implying that agrarian efficiency directly fuels economic momentum. Similarly, Uche et al. (2023) confirmed via OLS that Agricultural Credit Guarantee Scheme Fund (ACGSF) disbursements to SMEs substantially elevated both national and agricultural GDP between 2000 and 2020.

Mbelu and Ifioma (2022) leveraged error correction modeling to demonstrate that ACGSF funding positively influenced GDP from 1981 to 2019. Ikubor et al. (2022), relying on ARDL metrics, concluded that capital routed into economic services and agriculture positively spurred growth from 1981 to 2020. Etale et al. (2021) identified a positive linear trajectory connecting agricultural contributions directly to GDP expansion between 2000 and 2018. However, Victor (2019) utilized VECM to parse data from 1977 to 2012, discovering that while domestic farming production and ACGS boosted growth, total agricultural employment paradoxically exerted a negative drag on the economy.

Oladipo et al. (2024) determined that climate anomalies and agricultural loan schemes unexpectedly hampered Nigerian economic growth between 1986 and 2022, though capital state expenditure provided a stabilizing, positive influence. Edeh, Ogbodo, and Onyekwelu (2020) demonstrated via ARDL that while immediate capital expenditure massively benefited output, its potency evaporated after twelve months, whereas recurrent expenditure remained statistically irrelevant. Emmanuel et al. (2021) isolated sector-specific impacts, revealing that fishery and livestock operations significantly drove Nigerian economic growth (coefficients of 67.26 and 5.0526, respectively), while forestry and crop cultivation registered statistically insignificant, negative effects.

On a broader continental scale, Mostefai (2024) validated a robust short- and long-term linkage between real GDP and agricultural value added in Algeria. Ogundari (2021) evaluated 35 SSA countries, concluding that while agrarian productivity reliably dictates economic shifts across all timeframes, broader economic growth only impacts farming outputs over extended long-term horizons. Nonvide et al. (2021) utilized GMM dynamics to establish a definitive threshold of 31.8% for SSA nations (and 32.6% for ECOWAS members), indicating the precise point at which the economic benefits of agricultural value added begin to sharply diminish. Zemri and Khetib (2023) analyzed Algerian data (1990–2021), noting that while production volumes dictated short-term

growth and value-added metrics controlled long-term trajectories, basic agricultural employment remained statistically inert. Finally, Manasseh et al. (2024) highlighted the dual nature of credit channels, which produced simultaneously negative and positive long-term effects on SSA agrarian development. Consequently, the overarching literature confirms that the agriculture-growth nexus is profoundly heterogeneous, fluctuating wildly based on institutional integrity, fiscal architecture, and specific methodological approaches.

Data and Research Methodology

This empirical analysis relies on variables including the log of real GDP per capita (GDPpc), agricultural value added (AVD), the ratio of employment in agriculture (EIAG), real exchange rates (REXR), inflation (INF), interest rates, and government expenditure (GEXP). Data sets span from 1970 to 2018, encompassing Nigeria, Zambia, South Africa, and Ethiopia—nations responsible for the lion's share of continental agrarian output, chosen expressly for their robust data availability via World Development Indicators (WDI). The study utilizes GDPpc and real GDP as dual proxies for economic momentum, while anchoring agrarian progress to AVD and EIAG metrics. Introducing real GDP, EIAG, and GEXP acts as a stringent robustness check, alongside evaluations of dynamic interactive regressor effects. The research operationalizes the linear ARDL framework articulated by Pesaran et al. (2001), formulating the baseline panel model as:

$$Growth_t = \varphi_0 + \sum_{i=1}^{p} \varphi_i \, x_{t-i} + \sum_{j=0}^{q} \beta_j \, z_{t-j} + \varepsilon_t$$

Here, ε_t represents the error term, x_t stands for an autoregressive component clarified by lagged variables, and z_t designates the distributed lag components of the regressors. Regardless of whether explanatory variables integrate at I(0) or I(1), the ARDL framework flawlessly generates normal long-run coefficients, proving markedly more reliable for cointegration than methodologies proposed by Johansen (1988) or Engle and Granger (1987). The equation translates to assess specific variables as follows:

$$\ln P\,CGDP_{i,t} = \varphi_{i,t} + \beta_t \ln Q_{i,t} + \rho_t \ln R_{i,t} + \varepsilon_t$$

In this specification, N and T represent observational units and time frames. $PCGDP_{i,t}$ denotes economic growth, while $Q_{i,t}$ contains core agricultural variables (AVD and EIAG), and $R_{i,t}$ houses macroeconomic controls (inflation, exchange rates, interest, and government spending). Transitioning this into a linear ARDL (1, 1) architecture yields the following structures to evaluate short- and long-run synergies:

$$\Delta \ln P\,CGDP_{i,t} = \varphi_2 + \sum_{i=1}^{n} \pi_3 \, \Delta \ln P\,CGDP_{t-1} + \sum_{i=0}^{n} \beta_t \, \Delta \ln Q_{t-1} + \sum_{i=0}^{n} \rho_t \, \Delta \ln R_{i,t-1} + \lambda_3 \ln P\,CGDP_{t-1} + \gamma_t \ln Q_{i,t-1} + \xi_t \ln R_{i,t-1} + \vartheta_t$$

$$\Delta \ln AVD_{i,t} = \varphi_2 + \sum_{i=1}^{n} \pi_3 \, \Delta \ln P\,CGDP_{t-1} + \sum_{i=0}^{n} \beta_t \, \Delta \ln Q_{t-1} + \sum_{i=0}^{n} \rho_t \, \Delta \ln R_{i,t-1} + \lambda_3 \ln P\,CGDP_{t-1} + \gamma_t \ln Q_{i,t-1} + \xi_t \ln R_{i,t-1} + \upsilon_t$$

The joint significance of the long-run multipliers is tested to confirm baseline relationships. Subsequently, the Error Correction Mechanisms (ECM) are derived to monitor the speed at which short-term deviations revert to equilibrium:

$$\Delta \ln PCGDP_{i,t} = \varphi_2 + \sum_{i=1}^{n} \pi_3 \Delta \ln GDPC_{t-1} + \sum_{i=0}^{n} \beta_t \Delta \ln Q_{t-1} + \sum_{i=0}^{n} \rho_t \Delta \ln R_{i,t-1} + \Gamma Ecm_{t-1} + U_t$$

$$\Delta \ln AVD_{i,t} = \varphi_2 + \sum_{i=1}^{n} \pi_3 \Delta \ln GDPC_{t-1} + \sum_{i=0}^{n} \beta_t \Delta \ln Q_{t-1} + \sum_{i=0}^{n} \rho_t \Delta \ln R_{i,t-1} + \eta Ecm_{t-1} + V_t$$

Within these equations, Δ signifies first difference operators, while Ecm_{t-1} quantifies the precise adjustment speed.

To enforce analytical rigor, pre- and post-estimation diagnostics were executed, including the Pesaran (2004) CD test, Breusch-Pagan (1980) LM test, and the Baltagi et al. (2012) bias-corrected LM test to detect cross-sectional dependencies typical in panel data. Stationarity was meticulously validated using Im, Pesaran & Shin (IPS, 2003) and Levin, Lin & Chu (LLC, 2002) unit root tests. LLC assumes homogenous autoregressive roots, mapped via:

$$\Delta Y_{i,t} = \alpha y_{i,t-1} + \sum_{j=1}^{P_i} \beta_{i,j} y_{i,t-j} + X_{i,t}\delta + \varepsilon_{i,t}$$

Conversely, IPS specifies individualized ADF regressions allowing heterogeneous dynamics across cross-sections:

$$\Delta Y_{i,t} = \alpha_i y_{i,t-1} + \sum_{j=1}^{P_i} \beta_{i,j} \Delta y_{i,t-j} + X_{i,t}\delta + \varepsilon_{i,t}$$

Finally, a Hausman evaluation dictated the employment of fixed-effect estimations over random-effects models wherever the p-value sank below the 5% threshold.

Results Presentation and Discussion

Descriptive Statistics and Unit Root Tests

Initial descriptive statistics verify that the dataset remains fundamentally robust without excessive deviation from the mean, as evidenced by standard deviations closely mirroring mean values. Minimum and maximum metrics stretch from -68.06 to 54.99 respectively. Although kurtosis and skewness indicators hint at minor deviations from perfect normality, the overarching distribution is stable enough for high-level ARDL application.

Because macroeconomic time series data necessitates stationarity to avoid spurious regressions, LLC and IPS unit root tests were aggressively deployed. The findings unambiguously confirm that zero variables integrate at order two (I(2)). Across both tests, the null hypothesis ($H_0: \alpha = 0$) is uniformly rejected in favor of the alternative hypothesis ($H_1: \alpha < 0$), establishing that the log metrics of GDPPC, RGDP, AVD, EIAG, REXR, INF, INTR, and GEXP strictly integrate at I(0) and I(1) levels, perfectly satisfying the preconditions of ARDL modeling.

Variable(s)	LLC (t-stat)	Integration	IPS (t-stat)	Integration
GDPPC	[-25.22]***	I(0)	[-3.861]***	I(0)
RGDP	[-5.020]***	I(0)	[-22.10]***	I(1)
EIAG	[-15.98]***	I(1)	[-14.10]***	I(1)
AVD	[-10.65]***	I(1)	[-19.05]***	I(0)
REXR	[-7.175]***	I(1)	[-14.10]***	I(1)
INTR	[-12.48]***	I(1)	[-10.60]***	I(1)
INFL	[-11.44]***	I(1)	[-13.43]***	I(1)
GEXP	[-17.46]***	I(1)	[-20.24]***	I(1)
Data derived directly from panel unit root estimations.				

Cointegration Tests

To unearth stable, long-range relationships among these heavily I(1) integrated variables, the study deployed Pedroni's (1999; 2004) residual-based cointegration architecture, cross-verified by Kao's (1999) methodology. The Pedroni analysis generated eleven outputs across seven distinct dimensional tests. Impressively, six of the eight within-dimension metrics—including Panel rho-statistic and Panel PP-statistic—achieved statistical significance at the 1% benchmark across all six primary models. Concurrently, 100% of the between-dimension tests (Group rho, PP, and ADF) hit the 1% significance threshold. This comprehensive rejection of the no-cointegration null hypothesis decisively cements the existence of enduring, long-run equilibrium across the evaluated African economies, a conclusion flawlessly echoed by the Kao ADF-Statistics which similarly registered 1% level significance uniformly across the analytical spectrum.

ARDL Estimation and Stability Tests

The Hausman diagnostic isolated fixed effects as the superior estimator for the majority of the panel models (yielding p-values of 0.000 for stat values like 77.73, 50.32, 20.39, and 33.57), while confirming random-effects suitability in minor instances. Unanimously, all models sailed through the Jacque-Bera normality thresholds, Breusch-Godfrey autocorrelation parameters (no serial correlation present), and white test homoscedasticity checks, proving total systemic reliability.

The empirical ARDL outputs illuminate profound truths regarding the SSA macroeconomic terrain. A highly significant lagged dependent variable across multiple models (e.g., 0.730***) underscores deep path-dependency, wherein historical growth trajectories heavily dictate modern economic limits. Employment in agriculture (EIAG) surfaces as a titanic growth catalyst, returning positive, significant coefficients against both GDPpc and RGDP metrics (0.674*** and 0.298***, respectively). This explicitly validates the strategy of expanding rural workforce absorption to stimulate national wealth, a reality starkly visible in nations like Uganda and Ethiopia.

Agricultural value-added (AVD) showcases complex duality. It inexplicably depresses GDPpc in specific models (-0.113***) and produces negative interactions with inflation (-0.059), interest rates (-0.066), and exchange rates (-0.169). Yet, when pegged against RGDP, AVD erupts as a massively

positive force (0.391). This suggests that while raw agricultural output fattens the overarching GDP, systemic inefficiencies, low mechanization, and subsistence traps prevent this wealth from trickling down into individual per capita prosperity—a phenomenon heavily observed in Nigeria.

Macroeconomic controllers exert highly polarized influences. The real exchange rate (REXR) buoys GDPpc (0.049***) but severely strangles RGDP (-0.036***), encapsulating the double-edged sword of currency depreciation that rewards raw exporters while punishing local processors relying on imported machinery. Government expenditure (GEXP) generally turbocharges growth (0.510***), and its interaction with agrarian employment (EIAGGEXP at 0.051) proves that localized fiscal subsidies massively amplify rural job efficacy, echoing successful interventions in Rwanda. However, negative GEXP interactions with AVD (-0.072***) simultaneously warn of lethal fiscal misallocations and bureaucratic leakage.

Validating these dynamics, the Error Correction Model (ECM-1) uniformly registers negative, highly significant coefficients. For example, a coefficient of -0.744*** signals an aggressive recalibration mechanism wherein 74.4% of macroeconomic disequilibrium is rapidly annihilated in a single cycle, denoting structural resilience. Conversely, softer coefficients (-0.148) reflect sluggish institutional responses prone to prolonged stagnation. Furthermore, CUSUM recursive residual mapping decisively anchors all model pathways squarely within the 5% critical bounds, confirming total parameter stability from 1970 through 2018.

Granger Causality & Country-Specific Findings

Causality mapping exposes critical operational vectors for state planners. The data reveals unidirectional causality flowing strictly from GDPpc to EIAG, establishing that overarching macroeconomic heat generates agricultural jobs, rather than vice versa. Contrastingly, AVD and GDPpc maintain a powerful bidirectional symbiosis—stimulating one inherently triggers the other, creating a perpetual growth loop. Crucially, state capital spending (GEXP) unilaterally causes expansions in both agricultural employment and value addition, undeniably framing the sovereign government as the ultimate architect of rural agrarian survival.

Country-specific bounds testing further ratifies unique localized cointegration. In Ethiopia, massive GDP lag significance reflects the triumphs of their Agricultural Development-Led Industrialization (ADLI) framework, where farming jobs drive phenomenal growth despite negative drag from inefficient state expenditure rollouts. In Nigeria, although EIAG fosters long-term prosperity, its short-term negativity exposes the crippling reality of rural underemployment and missing mechanization, heavily compounded by toxic interest rates that suffocate smallholder credit access. South Africa's data illustrates a mature, industrialized transition: agricultural employment returns consistently negative coefficients, reflecting the sector's contraction to sub-3% of GDP amid intense automation and historical land imbalances, effectively conforming to Solow's neoclassical predictions of diminishing sectoral returns. Finally, Zambia exhibits erratic AVD outcomes directly tethered to rainfall dependency and an unbalanced reliance on maize, while inflation volatility continuously threatens its dual mining-agrarian economy. Across all these unique environments, highly significant negative ECM terms confirm that despite differing catalysts, each nation possesses an operational, recalibrating long-run economic equilibrium.

Summary, Conclusion and Policy Suggestions

This deep empirical inquiry into Ethiopia, Nigeria, South Africa, and Zambia conclusively proves that agrarian development—measured via AVD and EIAG—is a monumental driver of macroeconomic expansion (GDPpc and RGDP) spanning nearly five decades. Grounded securely in the Panel ARDL framework and validated by rigorous Pedroni and Kao cointegration mechanisms, the study definitively rejects all null hypotheses, confirming unbreakable long-term relationships linking farming vitality to sovereign wealth. The robust Error Correction Terms reveal that these economies correct disequilibria at varying velocities ranging from 14% to an astonishing 94% per cycle.

To aggressively exploit these confirmed agricultural synergies, African governments must initiate targeted legislative offensives. To supercharge AVD and EIAG, administrations should immediately deploy extensive tax exemptions and holiday periods specifically for medium and small-scale cultivators. Furthermore, state budgets must heavily subsidize the acquisition of modern technologies—ranging from high-yield seeds and agrochemicals to mechanical assets like transplanters, broadcast seeders, and crawler tractors. To shatter the barrier of exorbitant borrowing costs, governments must underwrite accessible soft loans, simultaneously deploying armies of elite extension officers to systematically upskill rural agrarian populations.

Innovation remains paramount; integrating state-of-the-art precision farming tech, such as advanced soil and hydration sensors, will allow farmers to scientifically modulate fertilizer and water usage, escaping the inefficiencies of traditional scheduling. Cultivating these advancements will trigger massive multiplier effects—exploding employment metrics, bolstering savings, stabilizing food reserves, and feeding raw materials directly into domestic industrial pipelines. Finally, because government expenditure mathematically triggers agrarian development, the execution of heavy infrastructural upgrades (roads, electrification, healthcare) is non-negotiable. To guarantee the purity of these investments in historically corrupt environments, states must assemble fiercely independent, heavily empowered ad hoc committees dedicated exclusively to monitoring and enforcing project delivery. Implementing these frameworks will successfully decouple powerhouses like Nigeria and South Africa from their dangerous reliance on raw mineral and petroleum exports, cementing a diversified, resilient future anchored in the soil.

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