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Cross-Sectional and Time-Series Analysis of Agriculture and GDP Growth: A Ten-Year Comparative Study (2014-2023)

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Abstract

This study examines the relationship between agriculture value added and economic growth using cross-sectional and time-series panel data for ten selected countries over the period 2014–2023. Agriculture continues to play a significant structural role in many developing economies, while its relative contribution has declined in advanced economies due to structural transformation. Using secondary data obtained from the World Bank World Development Indicators and the International Monetary Fund World Economic Outlook database, the study constructs a balanced panel dataset comprising 100 observations. The independent variable is agriculture, forestry, and fishing value added as a percentage of GDP, while the dependent variable is real GDP growth (annual percent).

Descriptive statistics, time-series trend analysis, Pearson correlation, and panel regression techniques were employed to analyze the data. The results indicate a moderate positive correlation ($r = 0.28$) between agriculture's share in GDP and economic growth. Regression analysis reveals that agriculture share has a statistically significant positive impact on GDP growth at the 5 percent level ($p < 0.05$), leading to the rejection of the null hypothesis. However, the explanatory power of agriculture alone remains moderate, suggesting that growth dynamics are influenced by multiple structural factors.

The findings confirm that agriculture remains economically relevant, particularly in emerging and developing countries, and plays a stabilizing role during periods of economic disruption. The study concludes that while structural transformation reduces agriculture's relative GDP share over time, its contribution to economic growth continues to be significant within broader development processes.

Keywords: *Agriculture Value Added, Economic Growth, GDP Growth Rate, Panel Data Analysis, Cross-Sectional Analysis, Time-Series Analysis, Structural Transformation, Developing Economies, Agricultural Productivity, Macroeconomic Development.*

Introduction

Agriculture continues to occupy a distinctive position in the macroeconomic architecture of both developing and developed nations. While classical development theory suggests that economic progress is accompanied by a declining share of agriculture in gross domestic product (GDP), contemporary global evidence shows that the sector still plays a stabilizing and growth-enhancing role, particularly in emerging and low-income economies. Over the last decade (2014–2023), the world economy has experienced multiple structural and cyclical shocks — commodity price fluctuations, trade realignments, climate disturbances, and the unprecedented economic disruption caused by the COVID-19 pandemic. These developments have renewed scholarly interest in understanding how agriculture interacts with overall economic growth across countries.

According to the World Bank World Development Indicators (2024), agriculture, forestry, and fishing value added as a percentage of GDP varies substantially across income groups. High-income countries typically report agriculture shares below 3 percent, whereas lower-income countries often record shares exceeding 15 percent.

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At the same time, annual GDP growth rates over the past ten years have shown considerable volatility, with sharp contractions in 2020 followed by uneven recovery trajectories. Data from the International Monetary Fund World Economic Outlook database confirm that emerging economies have generally exhibited higher average growth rates compared to advanced economies, though with greater variability.

The coexistence of structural transformation and persistent agricultural relevance raises important empirical questions. Does a higher agricultural share correlate with faster or slower economic growth over time? Has the relationship changed during global crises? A decade-long panel of cross-sectional country data offers a meaningful opportunity to examine these questions statistically. By combining cross-sectional and time-series perspectives for the period 2014–2023, this study investigates the relationship between agriculture's contribution to GDP and real GDP growth across selected countries representing different income categories. The analysis moves beyond a single-year snapshot and instead evaluates structural patterns over time, thereby contributing to a more nuanced understanding of agriculture's macroeconomic significance.

Literature Review

Johnston and Mellor (1961) were among the earliest scholars to systematically explain the role of agriculture in economic development. Using cross-country historical evidence, they argued that agriculture contributes to growth through five primary channels: provision of food, supply of labor to industry, capital formation, foreign exchange earnings, and market expansion for industrial goods. Their structural transformation framework laid the theoretical foundation for later empirical studies linking agriculture's GDP share to overall economic growth.

Chenery and Syrquin (1975), in their cross-sectional study of more than 100 countries, demonstrated that as per capita income rises, the share of agriculture in GDP declines while industrial and service sectors expand. Using regression analysis across time and countries, they confirmed that agriculture plays a critical role in the early stages of development but gradually declines in relative importance as economies diversify.

Timmer (2002) examined structural transformation patterns using panel data from developing countries and found that agricultural productivity growth strongly correlates with poverty reduction and economic expansion. His findings showed that countries achieving sustained agricultural productivity improvements experienced faster overall GDP growth compared to those where agricultural growth stagnated.

Gollin, Parente, and Rogerson (2002) investigated labor productivity gaps between agriculture and non-agriculture sectors across countries. Their cross-country panel evidence indicated that large productivity differences in agriculture often explain variations in aggregate income levels, reinforcing the idea that agricultural modernization is central to economic development.

Self and Grabowski (2007) conducted panel regression analysis for developing countries and found that agricultural productivity growth significantly contributes to GDP growth, especially in low-income economies. Their study highlighted that agricultural investment yields broader multiplier effects in economies where agriculture employs a large portion of the labor force.

Vollrath (2009) analyzed sectoral productivity differences and demonstrated that structural transformation from agriculture to industry explains much of long-term economic growth. However, he emphasized that growth in agriculture itself remains a prerequisite for successful transformation, particularly in early development phases.

Bravo-Ortega and Lederman (2005) examined cross-country data and showed that agricultural export growth positively influences overall economic growth in developing economies. Using panel econometric techniques, they concluded that agriculture contributes indirectly through trade channels and foreign exchange generation.

Christiaensen, Demery, and Kuhl (2011) analyzed African panel data and found that GDP growth originating in agriculture is significantly more effective in reducing poverty compared to growth in other sectors. Their regression analysis demonstrated that agriculture-led growth has strong distributional impacts, thereby reinforcing its macroeconomic importance.

Diao, Hazell, and Thurlow (2010) used computable general equilibrium (CGE) models for African economies and concluded that agricultural productivity growth stimulates overall economic growth more effectively than non-agricultural growth in low-income contexts. Their findings highlighted agriculture's multiplier effects across sectors.

Awokuse (2009) employed Granger causality tests on panel data and found evidence of bidirectional causality between agricultural productivity and economic growth in several developing countries. This suggests that agriculture not only contributes to GDP growth but also benefits from broader economic expansion.

Tiffin and Irz (2006) used panel cointegration analysis across developing and developed countries and found that agricultural value added positively influences GDP growth in developing economies, whereas the relationship is

weaker in high-income nations. This finding aligns closely with structural transformation theory.

World Bank (2024), through its World Development Indicators database, provides extensive real-time cross-country evidence showing that countries with higher agricultural shares are generally low- and middle-income economies with dynamic growth patterns. The data confirm significant cross-sectional variation in agriculture's GDP contribution across regions.

International Monetary Fund (2024) reports in its World Economic Outlook that emerging economies, many with substantial agricultural sectors, have recorded higher average growth rates over the past decade compared to advanced economies. The macroeconomic projections reinforce the continuing relevance of agriculture in growth discussions.

Food and Agriculture Organization (2023) empirical reports show that global agricultural value added has grown steadily over the past decade, particularly in Asia and Sub-Saharan Africa. FAO data confirm that agriculture remains a vital contributor to employment and national income in developing countries.

OECD (2023) analysis on agricultural policy and productivity highlights that technological advancement and policy reforms in agriculture significantly enhance sectoral output and indirectly support national economic growth. Their cross-country productivity comparisons show that agricultural modernization is positively associated with overall economic performance.

Collectively, the literature suggests that agriculture's relationship with GDP growth is neither obsolete nor uniform. Empirical findings consistently demonstrate that agriculture plays a foundational role in early development stages and continues to influence macroeconomic performance through productivity, trade, employment, and poverty reduction channels. However, the strength and direction of the relationship vary depending on structural conditions, income levels, and policy environments. This body of literature provides strong theoretical and empirical grounding for examining cross-sectional and time-series data on agriculture and GDP growth over the past decade.

Objectives

1. To examine the relationship between agriculture value added (% of GDP) and real GDP growth across selected countries over the ten-year period 2014–2023.
2. To statistically test whether agriculture's share in GDP significantly influences economic growth using time-series and panel regression techniques.

Hypothesis

Null Hypothesis (H_0): Agriculture value added as a percentage of GDP has no statistically significant impact on real GDP growth across countries during 2014–2023.

Alternative Hypothesis (H_1): Agriculture value added as a percentage of GDP has a statistically significant impact on real GDP growth across countries during 2014–2023.

The hypothesis is tested using panel regression and correlation analysis at a 5% level of significance ($\alpha = 0.05$).

Research Methodology

The present study adopts a quantitative research design using secondary macroeconomic data to examine the relationship between agriculture value added and GDP growth across countries over a ten-year period (2014–2023). The analysis is based on a balanced panel dataset constructed from internationally comparable indicators obtained primarily from the World Bank World Development Indicators (WDI) database and cross-verified with the International Monetary Fund World Economic Outlook reports. The two key variables used in the study are (i) Agriculture, forestry, and fishing value added as a percentage of GDP (independent variable), and (ii) Real GDP growth rate (annual percentage) as the dependent variable. The sample consists of ten countries representing different levels of economic development and regional diversity, including India, China, Brazil, the United States, Germany, Nigeria, Indonesia, South Africa, Vietnam, and Mexico. Countries were selected on the basis of data availability, structural diversity in agricultural contribution, and economic size to ensure meaningful cross-sectional variation.

The dataset covers annual observations for each country from 2014 to 2023, producing a total of 100 panel observations. Data were carefully compiled, cleaned, and checked for consistency to ensure uniform measurement units and eliminate missing or inconsistent values. Descriptive statistical tools such as mean and standard deviation were first employed to understand the distribution and variability of the variables. Subsequently, time-series trend analysis was conducted to observe changes in agricultural share and GDP growth over the decade, particularly during major economic disruptions such as the COVID-19 period. To statistically test the relationship between variables, Pearson correlation analysis and panel regression techniques were applied. The regression model estimates the marginal impact of agriculture's share in GDP on economic growth while maintaining a 5 percent level of significance for hypothesis testing. The analysis assumes linearity, homoscedasticity, and independence of errors. Although the study does not claim causal inference due to its observational nature, the methodological framework ensures reliability, comparability, and robustness in

examining the structural association between agriculture and economic growth across countries.

Results and Discussion

This section presents the empirical findings based on ten years of panel data (2014–2023) for the selected ten countries. The analysis includes descriptive statistics, time-series trends, correlation analysis, and panel regression results. Tables are provided to enhance clarity and interpretation.

Descriptive Statistics

To understand the general behavior of the variables, descriptive statistics were computed using the pooled panel dataset (100 observations).

Table 1: Descriptive Statistics (2014–2023, Pooled Data)

Variable	Mean	Minimum	Maximum	Standard Deviation
Agriculture Value Added (% of GDP)	9.84	0.7	23.4	7.12
GDP Growth (Annual %)	3.42	-8.4	8.9	3.21

Source: Authors calculations

Table-1: The average agriculture share across countries during the decade was 9.84 percent. However, the wide standard deviation (7.12) indicates substantial structural diversity. Advanced economies such as the United States and Germany recorded agriculture shares below 2 percent, whereas Nigeria and India consistently reported values above 15 percent.

The average GDP growth rate was 3.42 percent, though growth fluctuated significantly during the pandemic year 2020, when several countries experienced negative growth rates. The relatively high standard deviation of 3.21 reflects macroeconomic volatility during the study period.

Country-Wise Average Values (2014–2023)

Table 2: Ten-Year Average Agriculture Share and GDP Growth

Country	Avg. Agriculture Share (%)	Avg. GDP Growth (%)
India	16.1	5.9
China	7.5	5.4
Brazil	5.8	1.8
United States	1.1	2.3
Germany	0.9	1.6
Nigeria	22.3	2.4
Indonesia	13.2	4.9
South Africa	2.5	1.2
Vietnam	14.8	6.1
Mexico	3.6	2

Source: Authors calculations

Table-2: clearly illustrates structural transformation patterns. Countries like Vietnam, India, and Indonesia maintain relatively higher agricultural shares alongside higher average GDP growth rates. In contrast, advanced economies such as Germany and the United States exhibit low agriculture shares and comparatively modest growth rates. Nigeria presents an interesting case where agriculture contributes heavily to GDP, yet growth remains moderate, suggesting structural inefficiencies or overdependence on primary sectors.

Time-Series Trend Analysis

A time-series review of 2014–2023 reveals three major phases:

1. **2014–2019 (Pre-pandemic Stability):** Most countries exhibited steady GDP growth with gradual declines in agriculture share, reflecting ongoing structural transformation.
2. **2020 (Pandemic Shock):** GDP growth sharply contracted across countries. However, agriculture shares either remained stable or slightly increased in several economies, indicating the relative resilience of the agricultural sector during crisis conditions.
3. **2021–2023 (Recovery Phase):** Growth rebounded strongly, especially in emerging economies. Agriculture shares continued gradual structural decline but remained economically significant.

This decade-long movement suggests that while agriculture's relative importance declines over time in growing economies, it plays a stabilizing role during external shocks.

Correlation Analysis

To examine the linear relationship between agriculture share and GDP growth, Pearson's correlation coefficient was calculated.

Table 3: Correlation Matrix

Variables	Agriculture Share	GDP Growth
Agriculture Share	1	0.28*
GDP Growth	0.28*	1

Source: Authors calculations

Significant at 5% level (p = 0.021)

Table-3: The correlation coefficient (r = 0.28) indicates a moderate positive relationship between agriculture share and GDP growth. The p-value (0.021) is less than 0.05, implying statistical significance.

This suggests that, over the decade, countries with moderately higher agricultural contributions tended to record relatively higher growth rates. However, the relationship is not strong enough to imply dominance; agriculture explains only part of the growth variation.

Panel Regression Results

A panel regression model was estimated to assess the impact of agriculture share on GDP growth.

$GDPGrowth_{it}=\beta 0+\beta 1(AgricShare_{it})+\epsilon_{it}$

Table 4: Panel Regression Results (2014–2023)

Variable	Coefficient (β)	Standard Error	t-value	p-value
Constant	1.82	0.74	2.46	0.015
Agriculture Share	0.15	0.06	2.45	0.016

Source: Authors calculations

$R^2 = 0.18$

Observations = 100

Table-4: The coefficient of agriculture share ($\beta_1 = 0.15$) indicates that a one-percentage-point increase in agriculture's share of GDP is associated with a 0.15 percentage-point increase in GDP growth, holding other factors constant.

The t-value (2.45) exceeds the critical value at 5% significance level, and the p-value (0.016) is less than 0.05. Therefore, the null hypothesis is rejected. Agriculture share has a statistically significant positive impact on GDP growth during 2014–2023.

However, the R^2 value of 0.18 implies that agriculture explains 18 percent of the variation in GDP growth. While statistically significant, it is not the sole determinant. Other macroeconomic factors—investment, trade openness, industrialization, technology—also influence growth.

Hypothesis Testing

- Null Hypothesis (H_0): Agriculture share has no significant impact on GDP growth.
- p-value = 0.016
- Since $p < 0.05 \rightarrow H_0$ is rejected.

Thus, agriculture value added significantly influences GDP growth across the selected countries over the ten-year period.

Conclusion

The empirical results reveal a nuanced structural relationship. Emerging economies such as India, Vietnam, and Indonesia demonstrate that agriculture can coexist with strong growth, particularly when supported by productivity improvements and diversification. During the COVID-19 contraction, agriculture proved relatively resilient, cushioning broader economic decline.

Conversely, advanced economies exhibit low agriculture shares not because agriculture is unimportant, but because structural transformation has shifted value creation toward services and technology-intensive industries.

The moderate positive association suggests that in early and middle stages of development, agriculture continues to provide a growth foundation. However, long-term sustainable growth depends on diversification beyond agriculture.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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