International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2025, 15(6), 28-33.

Exchange Rate and Agricultural Sector Performance in South Africa: Time Series Analysis Approach

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Received: 14 March 2025 **Accepted:** 23 July 2025 **DOI:** https://doi.org/10.32479/ijefi.19800

ABSTRACT

The study investigated the intricate relationship between exchange rate fluctuations and the performance of the agricultural sector in South Africa data spanning from 1986 to 2022. Compound methodology was employed for analysis, where Johansen cointegration tests reveal the presence of long run relationship among the variables after series became stationary after first difference using Augmented Dicker Fuller. Pearson correlation matrix highlights the positive effect of real exchange rate fluctuations on the gross value of agricultural production, with agricultural exports playing a significant role in driving this relationship. Further analysis using the Fully Modified Ordinary Least Squares model confirmed a positive and statistically significant relationship between agricultural exports and the gross value of agricultural production. This suggests that policies promoting increased agricultural exports could lead to higher agricultural production values. The study recommends policymakers focus on implementing measures to stabilize and predict exchange rates, which can positively influence agricultural sector performance.

Keywords: Agricultural Exports, Correlation Matrix, Economic Performance, Exchange Rate, Fully Modified Ordinal Least Square
JEL Classifications: Q17, C10, Q47, F31, C22

1. INTRODUCTION

Agriculture is crucial for economic expansion, poverty reduction, and food security in Southern Africa, with over 70% of the rural population relying on it for their livelihoods. However, the underperformance of the agricultural sector has hindered regional economic development (Ibrahim et al., 2022). However, agriculture, forestry, and fishing contributed 0.1% points to growth in the overall economy in the second quarter of 2023 with a growth rate of 4.2%. Horticulture and field crop cultivation accounted for most of this growth. A total of nine out of ten divisions reported positive growth in the second quarter of 2023, as well as the manufacturing sector which grew by 2.2% in the second quarter (Aye et al., 2015).

South Africa, well-known for its abundant agricultural legacy, holds a key position in global food production. The nation's wide variety of crops and livestock makes a significant contribution to its economic well-being and food stability (García-Díez et al., 2021). Nonetheless, the unpredictable nature of exchange rates adds complexity that can greatly influence the agricultural sector's outcomes (Anderson, 2022). It is essential for policymakers, economists, and stakeholders to grasp the intricacies of this connection.

Fluctuations in exchange rates, driven by various factors like global economic shifts, political stability, and market sentiment, significantly influence the competitive edge of South Africa's agricultural exports. A favorable exchange rate can boost export competitiveness, making the nation's agricultural goods more appealing in global markets (Etale and Ochuba, 2019). Conversely, a depreciating currency can pose challenges for the sector, impacting profitability and market accessibility.

Muzekenyi et al. (2019) analyzed the effect of the real exchange rate on South African economic growth using the vector error correction model (VECM). In both the short- and long-terms, the real exchange rate negatively affects economic growth. This interaction between exchange rates and the agricultural sector is particularly significant in South Africa's diverse and dynamic frugality (Nthebe and Mosikari, 2025). This study aims to uncover the complex association among exchange rates and agricultural performance, including their impact on input costs like fertilizers and machinery, which are crucial for farmers. Understanding these dynamics is essential for crafting policies that support the resilience and sustainability of the agricultural sector in South Africa.

2. LITERATURE REVIEW

Historically, economists have acknowledged that exchange rates have an important influence on trade. The influence of exchange rates on commodity prices has recently gained greater sensitivity and curiosity among agricultural producers. The robust rand is perceived as a key factor contributing to depressed farm prices. Exchange rates are key factors in assessing the value of farm production and equipment in the modern era, characterized by a rapidly expanding global economy and ever-evolving international trade regulations. In agricultural economics, exchange rates played an integral role for many years.

Yazici (2008) examined were the exchange rate and trade balances of agriculture in Turkey, Manufacturing, and Mining. In this study, the trade balances of these three sectors in Turkey were compared and examined in relation to exchange rate fluctuations. The analysis utilized 3-monthly data spanning as of 1986: I-1998: III. The findings indicated that, following national currency decline, the trade balance of each sector initially improved, then deteriorated, and subsequently improved again. Despite showing a comparable outline of short-term reactions to exchange rate changes, the long-term and overall responses of trade balances varied through the subdivisions. While both the manufacturing and mining sectors experienced improvements in trade balances over the long run, the agricultural sector's trade balance worsened due to the depreciation of the domestic currency.

Schuh (1974) authored a paper investigating the impact of exchange rates on U.S. agriculture, aiming to understand their influence on trade and development challenges within this sector. The paper highlights the oversight of exchange rate policy in nonparametric analyses, utilizing a model of induced technical change. It acknowledges the historically high agricultural prices in the early 1950s and attributes subsequent declines to various factors, including trade restrictions, exchange rate impacts on foreign markets, and broader economic development influences. The paper does not assert that the over-valuation of the dollar or recent devaluations are the sole causes of changes in agricultural prices. Instead, it argues that exchange rates have played a significant role in these phenomena, which has been largely overlooked. It emphasizes the need for a more comprehensive understanding of the agricultural sector's performance through a thorough consideration of exchange rate dynamics.

Chambers and Just (1981) studied the impact of exchange rate changes on U.S. Agriculture, focusing on wheat, corn, and soybean markets using a dynamic analysis. Their research employed a specific quarterly econometric model for these markets, exploring how exchange rate fluctuations affected domestic and foreign aspects. The findings showed that such fluctuations significantly influenced agricultural markets, leading to shifts in export volumes and the balance between exports and domestic usage of these commodities. This challenges the general applicability of conclusions proposed by Miles and Laffer to agricultural markets. Further, the study sought to understand how exchange rates influence agriculture dynamically, revealing a complex and lengthy adjustment process. Adjustments in disappearance, inventories, and exports varied among crops, accordingly, the dollar's devaluation and successive floating has had an impact on the allocation of resources in the U.S. economy.

Adekunle and Ndukwe (2018) examined the potential asymmetric impact of real exchange rate fluctuations on agricultural output in Nigeria from 1981 to 2016, utilizing data obtained from secondary sources. A mix of stationary and non-stationary variables was identified through the ADF unit root test. The Bounds test for cointegration indicated no long-run relationship between the real exchange rate and agricultural output, regardless of model specifications. Overall, the model estimation results highlighted key determinants of agricultural output, including the real exchange rate (log-levels), real appreciation and depreciation (after certain lags), industrial capacity utilization rate, and government expenditure on agriculture (with lagged effects). The ACGSF loan had a positive but statistically insignificant effect on agricultural output. Additionally, although real appreciation had a greater impact than real depreciation, the study found no evidence supporting the asymmetric effect of real exchange rate movements on agricultural output in Nigeria.

Mroua and Trabelsi (2020) investigate the causal links and dynamic interdependence between fluctuations in exchange rates and volatility in stock market indices across BRICS countries from January 2008 to February 2018. Employing a dual approach involving the dynamic panel GMM model and the ARDL method are used to evaluate both short-term and long-term relationships. The findings from the panel GMM model indicate that fluctuations in exchange rates and previous-day stock market index returns significantly affect the volatility of current returns in BRICS indices. In contrast, the results from the PMG/ARDL model suggest that historical stock market index returns have a significant influence on current returns only in the long run. Overall, the study underscores the considerable impact of exchange rate variations on both short- and long-term returns across the market indices of all BRICS nations.

Sylvanus et al. (2023) explored the effect of foreign exchange rates on the agricultural export performance in Nigeria. Despite the emphasis on utilizing foreign exchange to boost agriculture in Nigeria, the country's agricultural exports continue to face challenges. The study covered the period from 1986 to 2021, employing an ex post facto research design and utilizing the ARDL, ECM method, cointegration, and unit root test for analysis. The results indicated that foreign exchange rates exhibited a negative but statistically insignificant impact on the. Volume and value added in Nigeria's agricultural sector. However, there was a positive and significant impact on agricultural capacity utilization. In light of these findings, the study recommends that the Nigerian government should regulate and moderate exchange rate activities to ensure improved performance in the agricultural sector.

Ahmed et al. (2024) assessed the impact of exchange rate liberalization on investment in the Egyptian Agricultural Industry. This research aimed to accomplish the following objectives: - Examining the trend of exchange rate fluctuations alongside total investments in the agricultural domain. Analyzing the effectiveness of agricultural investments in Egypt spanning from 2000 to 2019. - Investigating the influence of exchange rate liberalization on Egyptian agricultural investment. The findings underscore the necessity of diligently considering exchange rate dynamics and policies to formulate a balanced and dependable budget conducive to enticing investors to the agricultural sector. Such measures hold the potential to foster elevated levels of agricultural and economic advancement in Egypt.

Olamide et al. (2022) examined the repercussions the impact of monetary policy and exchange rate fluctuations on investment in South Africa is examined using secondary time series data from 1991 to 2020. Employed traditional unit root tests, indicating stationarity and integration of order zero and one. Utilized autoregressive distributed lag to establish cointegration bounds, yielding short and long-term outcomes. Revealed a cointegrated long-term relationship among the variables. Specifically, interest rates, money supply, inflation, and exchange rate volatility showed diverse impacts on investment over both short and long periods. The money supply had a positive effect on investment in both time periods, whereas exchange rate volatility had a negative impact on investment in South Africa. Diagnostic tests affirmed the model's stability, normal distribution, and absence of issues like serial correlation and heteroskedasticity.

3. METHODOLOGY

This section provides details about the dataset source, descriptive statistics, unit root test using the Augmented Dickey-Fuller (ADF) test, and the inferential analytical methods employed. The analytical method of inferential statistics encompasses the Johansen cointegration test among included variables; The Correlation matrix for evaluation of the relationship among variable and Fully modified ordinary least squares (FMOLS) Model which is an approach for calculating coefficients of linear regression equations which outline the interactions among exchange rate shifts and the agricultural sector's performance in South Africa (simple or multiple linear regression).

3.1. Data Set

The paper made use of yearly date of observations from 1986 to 2022 to explore the nuanced association among exchange rate movements and the agricultural sector's performance in South Africa. The South African Reserve Bank (SARB) supplied data regarding the South African exchange rate pegged to the US dollar. The agricultural exports and production dataset were obtained from the Department of Agriculture, Land Reform and Rural Development (DALRRD) in conjunction with Statistics South Africa.

3.2. Model Specification

The aim of the study is to empirically investigate the relationship between exchange rate fluctuations and the performance of the agricultural sector in South Africa. The suitable method for modelling these complex relationships is the Pearson Correlation Coefficient (PCC) suggested by Benesty et al. (2009). The importance of Pearson correlation analysis is that it indicates the strength of the linear relationship among the random variables.

The PCC model employed in this study can be outlined as follows:

Cov $(AE, AI, RER, GPAV)$ $(AE, AI, RER, GPAV)$ = σAEσAIσRERσGPAV

Where: $(AE, AI, RER, GPAV)$ = Pearson correlation coefficient

Cov $(AE, AI, RER, GPAV)$ = Covariance of variables

σAEσAIσRERσGPAV = Standard deviation of variable

Fully modified ordinal square model (FMOLS) is a suitable approach for the calculation of the connection among exchange rate and agricultural performance in South Africa. The estimation insight derived from studies by Thaba et al. (2020) and Tochukwu et al. (2021) involves modifying their model by excluding variables that are irrelevant to this research. Consequently, the model's functional form may be articulated as follows:

$$GVAP_t = \propto 1 + \beta 1 AI_t + \beta 2 AE_t + \beta 3 PRER_t + \varepsilon t$$

Meanwhile, $GVAP_t$ is Gross Value of agricultural production measured which is used as a proxy to agricultural sector's performance measured in Rands. AI_t is agricultural value of imports in tons. AE is agriculture value of exports in tons. RER is real exchange rate in South Africa. ε is error term, t spanning from 1986 to 2022. The a priori anticipation of the model ought to follow this pattern $\beta 1$ and $\beta 2 < 0$. $\beta 3 > 0$.

4. EMPIRICAL RESULTS AND DISCUSSION

This section presents and discusses the empirical findings from the research. Sequentially, with the unit root test coming after the descriptive statistics. Following that, the results of the cointegration test are examined, and the correlation matrix and FMOLS analysis are discussed using Ordinal Least Square estimation.

4.1. Descriptive Statistics

Table 1 shows minimum agricultural imports (AE_t) approximation corresponding to 1473.4 thousand ton, although its maximum worth amounts to 118947.8 thousand ton; the average mean value equals 35275.5 thousand ton and standard deviation summing to 36394.86. Minimum agricultural exports (AE_t) in South African is 3024.6 thousand tons, the maximum volume of exports is 210913.9 thousand tons, average value is about 53804.50 thousand tons and standard deviation amount to 58955.02. As shown in Table 1, the minimum real exchange rate (RERt) corresponds to R2.036033, the maximum real exchange rate is about R16.45911, although average mean is about R7.697359and standard deviation is equivalent to 0.527310. The minimum gross value of agricultural production ($GVAP_t$) is projected to sum to R11381 million; the maximum is equivalent to R401555.3 million, the total employment is about R119747.1 million and the standard deviation equals R110229.9 million.

4.2. Unit Root Test

Table 2 covers testing for stationarity in time series data, a major pre-test required to estimate relationships between variables. Unless well handled, a study that analyzes time series data could produce an erroneous or nonsense result. As a result, the standard ADF test was performed to determine the series' stationary status. Upon first differentiating, AIt, AEt, RERt and GVAPt are all stationary. This conclusion was drawn from looking at 5% significant level. In this study, all the data series are affected by unit roots, so they may all be susceptible to unit root problems.

4.3. Cointegration Analysis

The Johansen cointegration test was used in this study to determine if variables are associated with long-term outcomes. If the variables are not cointegrated, the null hypothesis is rejected. The cointegration test was guided by Akaike criterion of lag selection.

According to the outcomes of the Johansen cointegration test in Table 3, there is indication that components are cointegrated. The trace test specifies the presence of one cointegration link among the elements at the 5% level of significance. During the test, the null hypothesis, stating that the rank is 0, was assessed, and the P-value associated with the trace statistic was below 5%. Therefore, we reject the null hypothesis and assume that there is at least one cointegration connection within the system.

Table 4 offers the outcomes of the cointegration test utilizing maximum eigenvalue statistics for the variables. The Max-Eigen statistics demonstrates the presence of a cointegrated calculation at a significance level of 5%. In particular, at a 5% significance level, the Max-Eigen statistical test shows that there is one cointegration association among the two variables. Upon testing the null hypothesis with a rank of 0, the P-value associated with the trace statistic was observed to be below 5%, resulting in the rejection of the null hypothesis.

4.4. Correlation Analysis

Table 5 demonstrates that real exchange rate has positive association with gross value of agricultural production. This implies that real exchange rate volatility contributes to gross value of agricultural production. Aye et al., (2015) and Azeez et al., (2012) found the same results that exchange rate has positive relationship with economic growth. Agricultural exports as well have strong positive effect on gross value of production since the number is closer to one. This implies that the higher the agricultural exports the higher the level of gross value of agricultural production. This result conforms to Thaba et al. (2023)

Table 1: Summary of statistical properties for the variables

Properties/ variable	Descriptive statistics			
	Minimum	Maximum	Mean	Standard deviation
AI_t	1473.400	118947.8	35275.50	36394.86
AE_t	3024.600	210913.9	53804.50	58955.02
RER_t	2.036033	16.45911	7.697359	0.527310
$GVAP_t$	11381.00	401555.3	119747.1	110229.9

Source: Own computation, (2025)

Table 2: Result of the unit root test using ADF

Variables	ADF test				Decision
	Level [$I(0)$]	Probability	1st Dif [$I(1)$]	Probability	
AI_t	−0.5037	0.9787	−3.6689	0.0091	$I(1)$
AE_t	2.0872	1.0000	−6.3990	0.0000	$I(1)$
RER_t	−0.8720	0.9450	−5.9600	0.0002	$I(1)$
$GVAP_t$	−2.1607	0.4960	−5.3761	0.0005	$I(1)$

Source: Own computation, (2025)

Table 3: Result of the cointegration test using trace statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	0.05 critical value	Probability**
None	0.693801	92.06666	63.87610	0.0000
At most 1*	0.640354	51.82695	42.91525	0.0051
At most 2	0.296193	17.05739	25.87211	0.4107
At most 3	0.139668	5.114854	12.51798	0.5800

Source: Own computation, (2025)

Table 4: Result of the cointegration test using Max-Eigen statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	0.05 critical value	Probability**
None	0.693801	40.23971	32.11832	0.0041
At most 1*	0.640354	34.76956	25.82321	0.0025
At most 2	0.296193	11.94254	19.38704	0.4205
At most 3	0.139668	5.114854	12.51798	0.5800

Source: Own computation, (2025)

Table 5: Correlation matrix results

	AI_t	AE_t	$GVAP_t$	RER_t
AI_t	1	0.98868533	099120517	0.93223098
AE_t	0.98868533	1	0.99532523	0.93291318
$GVAP_t$	0.99120517	0.99532523	1	0.93938657
RER_t	0.93223098	0.93191318	0.93938657	1

Source: Own computation, (2025)

Table 6: Fully modified ordinary least square results

Regressors	Coefficient	T-statistics	Probability value
C	−492.6684	−0.0801	0.9366
AI_t	0.6685	2.4078	0.0218
AE_t	1.3341	8.2298	0.0000
RER_t	13342.05	3.0598	0.0044
R-squared	0.64500		
Durban Watson	1.9872		

Source: Own computation, (2025)

study that looked at exchange rate management and agricultural sectoral output performance.

4.5. FMOLS Model

Table 6 illustrates the long run estimated outcomes of the relationship among the included variable in South African agricultural sector utilizing Fully Modified Ordinary Least Square procedure. The Durbin Watson value is 1.9872, which demonstrates that the model does not suffer from auto correlation the number is very close to 2. The R-Squared which is 0.645 shows that AI_t, AE_t, and RER_t conjointly enlightened about 64% of the systematic differences in gross value of agricultural production. This suggests that the model performs reasonably well for the study's analysis. Agricultural exports indicate a positive relationship with gross value of agricultural production and statistically significant. The implication is that when the agricultural exports in South Africa increase also gross value of agricultural production will increase. This finding is supported by, Mitullah et al. (2017) in Kenya, and Girard (2017) for South Africa.

5. CONCLUSION

The research empirically explored how changes in exchange rates impact the agricultural sector's performance in South Africa. It employed various statistical methods, including the ADF test to examine for unit roots in the dataset. Additionally, inferential statistics such as the Johansen cointegration test were used to analyze relationships between variables. Trace and MaxEigen statistics were employed to validate these relationships. A correlation matrix was also utilized to assess the connections between different variables. Furthermore, the study utilized the Fully Modified Ordinary Least Squares (FMOLS) Model to estimate coefficients in linear regression equations, elucidating the link among exchange rate fluctuations and the agricultural sector's performance in South Africa.

The ADF test results indicated the nonappearance of a unit root issue amongst the variables, as evidenced by a 5% significance level, allowing for a cointegration test. During this test, both the Trace and Max-Eigen statistics were utilized to assess the null hypothesis, which suggested a rank of 0. The P-value associated with the trace statistic was found to be below 5%, resulting in the rejection of the null hypothesis and the assumption of at least one cointegration association within the system. Analysis of the correlation matrix revealed that fluctuations in the real exchange rate contribute to changes in the gross value of agricultural production. Additionally, agricultural exports were found to have a strongly positive impact on the gross value of production, with a value closer to one indicating a direct relationship between higher agricultural exports and increased gross value of agricultural production.

The results from the Fully Modified Ordinary Least Squares (FMOLS) analysis further confirmed a positive and statistically significant association among agricultural exports and the gross value of agricultural production. This suggests that a rise in agricultural exports in South Africa would lead to a corresponding increase in the total value of agricultural output.

This study recommends that policymakers should consider implementing policies that promote stability and predictability in exchange rates, as these measures can have a positive impact on the agricultural sector's performance. Additionally, providing support for capacity-building initiatives aimed at enhancing the resilience and competitiveness of farmers in response to exchange rate fluctuations is crucial. This support can encompass training programs, access to finance, and technical assistance.

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